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SYMPOSIUM ON WAR MEDICINE. I.

Guest Editorial

THE PROFESSION'S WAR RESPONSIBILITY

COLONEL JAMES M. PHALEN, EDITOR, THE MILITARY SURGEON

IT WAS with a sharp note of dissatisfaction and of warning to the medical profession of the country that Mr. Paul V. McNutt, Chief of the War Man Power Board, spoke to a session of the American Medical Association at its Atlantic City meeting in June, 1942. In direct and unequivocal terms he stated that the voluntary program for meeting the medical needs of the armed forces and of war industries had been a failure, and that unless the plan produced greatly improved results within a short period "a more vigorous plan," presumably the draft of medical personnel, would have to be put into operation.

Following the statement that the needs of the Army and Navy for medical officers were not being met, he said that it was apparent that the "careful safeguards" that had been set up by the Association's Procurement and Assignment Service had slowed down the rate of recruitment of doctors for the services. If this be indeed so, it is an example of a miscarriage of well-laid plans. The program for procurement and assignment was the result of diligent and well-considered planning by thoroughly competent men. It was calculated to feed medical officers into the armed services as they were needed, to provide skilled attendance to workers in the war industries, and to guarantee that the civilian population should not be deprived of medical attendance. The functions of the agency were of necessity decentralized, the unit of administration being a state board. Why these theoretically perfect plans have not produced the results expected is difficult to say. Mr. McNutt did not elaborate upon his general indictment of the "careful safeguards" of the Association program. The criticism would indicate an undue solicitude for the wants of the civil population.

The speaker charged a marked difference in the enthusiasm of doctors for voluntary service between the war of 1917-1918 and the present conflict. The figures that he gave for voluntary inductions into the services during comparable periods of the two wars, if they could be accepted as wholly valid, would constitute a keen indictment of the present generation of physicians. But conditions were by no means the same and really just comparisons are not possible. There have been, however, very convincing evidences of reluctance of eligible physicians to enter the military services. The lowering in 1940 of the draft age from 34 to 28 years was quickly followed by a marked drop in voluntary inductions of physicians who would otherwise be subject to the draft. The restoration of the former age limits acted as a distinct spur to recruiting.

We cannot question Mr. McNutt's statement that recruitment of the medical profession had not been satisfactory. He said that 5,000 additional doctors were needed before the end of June, 1942, and 20,000 more before the end of the year. These figures give a vivid picture of an acute recruitment problem. The estimate was made that it would take one-third of the physicians of the country to meet the needs of the armed services and that this would embrace two-thirds of those under the age of 45 years.

Dr. Fred W. Rankin, the incoming president of the Association, could only agree with the main items of criticism and that the profession had a definite responsibility in the allotment of its services in this time of emergency. He cited the progress that was being made in bringing back into active practice a great number of retired or semiretired physicians, thus making possible the release for military service of many otherwise indispensable practitioners of younger years.

The basic fact is that there are not enough doctors in the country for essential services. Like sugar and gasoline, they must needs be rationed. The task of this rationing was assigned to the Procurement and Assignment Service, which is now under criticism. The voluntary features of this plan will be followed until they are found definitely lacking. Only then can we look for the rationing to fall into other hands and the "more vigorous plan" put into effect.

THE ROLE OF CONTEMPORARY MEDICINE IN THE CURRENT WAR EFFORT

LIEUT. COL. JOSEPH ROGERS DARNALL, M.C., U. S. ARMY

AS CIVILIZATION staggers painfully through the kaleidoscopic tragedy of another World War, the characters in this great drama emerge and assume their destined roles. Medicine is honored with an heroic but difficult part in this colossal play, and proper performance is essential if the Axis villain is to be destroyed and the drama is to end happily.

This is by no means the first time that medicine has served humanity by playing a beneficient part in the promulgation of war. Since the days of Moses, the first great sanitarian, civilizations have risen and fallen as a result of the influence of disease upon military campaigns.

While inventive genius throughout the ages has perfected deadlier weapons, so also the minds of men have devised more effective protective measures to preserve the human race. The ever-increasing strength of scientific medicine provides a powerful bulwark against the rising tide of destructive warfare which is sweeping over the world today.

It is not my intention to review the medical accomplishments of former years other than to mention briefly a few of the outstanding achievements since 1914, and then to outline the contributions that are now being made by medicine toward the successful prosecution of the war. Many medical contributions to the current war effort would be impossible were it not for the advances in medicine which occurred during previous military conflicts or as a result of them.

During Kaiser Wilhelm's bloody bid for immortality in those hectic years of 1914-1918, preventive medicine climbed to new heights. Standardized methods of controlling and treating venereal diseases, initiated by the United States Army in 1909, were developed on a large scale in 1917. The undisputed value of typhoid vaccine and of tetanus antitoxin was established beyond doubt as a result of the experience of World War I. The cause of that great louse-borne scourge, trench fever, was discovered, and the control of this important war disease which sapped the fighting strength of great armies was accomplished. Following the Armistice, the determined attack of American medicine on typhus fever in Serbia and Poland demonstrated the usefulness of intensive educational campaigns as a means of controlling communicable disease.

The first World War also stimulated progress in air-conditioning, in rat-proofing, and in aviation medicine. In general, there was an enormously increased dissemination of knowledge concerning hygiene and sanitation, and a healthy expansion of clinical activities in the field of public health following the Armistice of 1918.

Internal medicine gained ground as a result of experience acquired on the battlefields and in the hospitals and laboratories a quarter of a century ago. Extensive investigation of respiratory diseases was stimulated by the pandemic of influenza. As the years unfolded, the laboratory segregated and subdivided the numerous pneumococcus pneumonias. During World War I a therapeutic antitoxic serum was developed to combat the dreaded gas gangrene. The problems and vast experience of that war spurred neuropsychiatry to greater knowledge, and better care for the victims of permanent psychoses was encouraged. Fever therapy of neurosyphilis was inaugurated when the malarial blood of two "shell-shocked" German soldiers was injected into the veins of paretic patients with encouraging results.

"Functional" disorders of the heart and of the neurovascular mechanism became conspicuous during the war. Later, as time relentlessly rolled by, veterans with degenerative cardiovascular disease presented themselves for treatment at government hospitals in ever-increasing numbers, thus focusing attention on those "middle-age" maladies which have made the profession more "coronary conscious."

Little need be said of the well-known contributions of World War I to the advancement of surgery. Battle casualties provided a vast clinical material which resulted in improved surgical knowledge and technique. Mention should be made, nevertheless, of the improved management of orthopedic cases, the Orr method of treating compound fractures, revival of debridement, and development of the Carrel-Dakin technique. The war gave birth to thoracic surgery and produced improved treatment of empyema, shock, osteomyelitis, and septic arthritis, to say nothing of the great gains made in faciomaxillary and plastic surgery, or of improvements in the suturing of blood vessels and nerves.

Physical therapy and occupational therapy were infused with life and became useful adjuncts of orthopedics and neuropsychiatry during and following the Kaiser's war to impose Teutonic Kultur upon an unwilling world.

It cannot be denied that military resistance to German aggression in 1914 also brought contributions in the field of medical organization, education, and literature. The examination of conscripts then, as now, drew public attention to the lack of physical and mental fitness and focused thought on the interrelated problems of medicine, economics, and sociology. The war showed medicine the value of teamwork and logical division of labor, so that specialization developed and group practice flourished when peace came.

Although much may be said concerning the contributions of war to the advancement of medicine, we are at present more vitally concerned with what medicine can contribute to successful prosecution of the war and a United Nations' victory.

With justifiable pride it may be pointed out that the medical departments of our armed services were not caught napping when the Japanese struck at Hawaii and the Philippines on Dec. 7, 1941. Long before that fateful date medical plans had been laid and preparations made to meet such an eventuality.

The advent of selective service training in 1940 signalized important developments in the mobilization of American medicine for war. These develop-

ments may be briefly summarized as follows: Beginning in June, 1940, at the request of the Surgeons General of the Army, Navy, and Public Health Service, the American Medical Association undertook a survey of the physicians of the United States, with special reference to their qualifications and availability. This was accomplished under the direction of the Committee on Medical Preparedness of the American Medical Association.

A total of more than 185,000 physicians received questionnaires from this Committee and by Jan. 2, 1942, more than 158,000, or nearly 86 per cent, had returned them. Considering the average physician's instinctive avoidance of paper work and hostility to questionnaires, this response of the profession was indeed a tribute to the cooperative spirit of American medicine in furthering the war effort.

Thus the foundation was laid for the establishment of the Procurement and Assignment Service for Physicians, Dentists, and Veterinarians on Oct. 30, 1941. This service, which is now under the War Manpower Commission, was established by the President as one of the subdivisions of the Office of Defense Health and Welfare Service. Another subdivision of the Office of Defense Health and Welfare Service is the Health and Medical Committee, which occupied adjoining offices and collaborated closely with the Procurement and Assignment Service. This Health and Medical Committee was first established on Sept. 19, 1940, by the Council of National Defense, "to advise the Council of National Defense regarding the health and medical aspects of National Defense and to coordinate health and medical activities affecting National Defense."

When, on Sept. 3, 1941, the President set up the Office of Defense Health and Welfare Service with Mr. Paul V. McNutt as Director, the Health and Medical Committee was transferred to that office. This committee deals with the more general aspects of medicine's participation in the war effort through its subcommittees on Dentistry, Hospitals, Industrial Health and Medicine, Medical Education, and Negro Health.

One of the first agencies to assist the Surgeons General of the Army, Navy, and Public Health Service in the current war effort was the Division of Medical Sciences of the National Research Council of the National Academy of Sciences. More than 40 committees and subcommittees, covering practically every field of medicine, were organized in 1940. These committees included more than 200 physicians, eminent in their various specialties.

The National Academy of Sciences was established by President Lincoln in 1863, under a Congressional charter which stipulated that the Academy, whenever called upon, should advise the government on any subject of science or art. It is significant that the need for such a scientific advisory body was keenly felt as long ago as the War Between the States.

The National Research Council of the Academy is composed of nine divisions, one of which is the Division of Medical Sciences. No less than 17 national societies of medicine and allied sciences are members of the Division of Medical Sciences.

The Division of Medical Science committees of the National Research Council do not duplicate the activities of the Health and Medical Committee of the

Defense Health and Welfare Service. The latter covers the more general aspects of health and national defense, while the National Research Council committees are called upon, as quasi-governmental agencies, for special professional advice and research.

Anticipating the likelihood of disease epidemics arising as a result of military mobilization, the Surgeon General of the Army, on Dec. 27, 1940, proposed the establishment of a "Board for the investigation and the control of influenza and other epidemic diseases in the Army." The creation of this board was approved by the War Department on Jan. 11, 1941, and the Surgeon General proceeded to organize the board by the assignment of a number of distinguished civilian consultants, each appointed by the Secretary of War.

The board is composed of (1) a central advisory group of seven members and (2) eight investigative commissions concerned primarily with the following eight problems: influenza, meningitis, measles, neurotropic virus diseases, streptococcus diseases, epidemiological surveys, pneumonia, and cross infections.

It may properly be deduced from the afore-mentioned steps to insure collaboration with the best civilian medical talent, that the medical departments of the armed services were keenly alert to the need for medical preparedness. The response of the profession in cooperating with the military by early organization of useful medical agencies to assist the preparedness program has been excellent.

The role of contemporary medicine, however, is not confined to *civilian* participation in the current war effort. It embraces also the organization and activities of the medical departments of our armed forces, which are primarily concerned with furnishing medical service to the Army and Navy. The mission of these medical departments is "to conserve fighting strength," and "to keep as many men at as many guns as many days as possible."

The principal part played by medicine in the first act of the drama of war was the selection of suitable military personnel by excluding from the armed services the physically and mentally unfit. This called for the formulation of appropriate physical standards, and the judicious interpretation of these standards by the thousands of physicians, civilian and military, who were called upon to accept or to reject volunteers for enlistment and selectees for induction.

In the second act of the military drama, medicine plays the part of a guardian angel. In this role, through the application of modern principles of sanitation and disease prevention, medicine protects against pestilence and strives to keep the military personnel, as well as industrial workers, in good physical condition.

In the third act of the war drama, tragedy is the keynote, and medicine appears as the healer of wounds and disease. The unfortunate participants, military and civilian, who become disabled must be furnished with such aid in the form of evacuation and hospitalization as will speedily restore them to health and fighting efficiency, so that the show may go on to the fourth and final act in which medicine assumes another major role in the rehabilitation of the disabled and in the reconstruction and stabilization of civilization. This last act is interminable and the curtain is never run down!

If American medicine is to accomplish its wartime mission, physicians must make great sacrifices as in 1917-1918. Since Pearl Harbor many medical veterans of World War I have developed "itching feet" and have been clamoring for another "hitch" of active duty. Many of them are now in uniform, and others, whose patriotism is unassailable, are "chafing at the bit." But active military service is largely a *young man's* game, and most of those who did their bit so magnificently in World War I, *when they were young men,* may now serve their nation best by guarding the home front.

Meanwhile, let the young physicians continue to come forward and fill the many positions in which their services are so sorely needed in the Army. These positions include not only professional assignments in hospitals and dispensaries, but also duties with tactical units. In time of combat each military unit the size of battalion or larger must be served by medical officers.

Field medical service, to be effective, requires adequate personnel to man the aid stations and unit dispensaries; to supervise evacuation of casualties; to establish and render professional service at collecting stations and clearing stations; to staff mobile surgical hospitals, evacuation hospitals, convalescent hospitals, field laboratories, and field medical supply installations.

Behind the combat zone in theaters of military operation, as well as in the zone of interior, medical men are needed at air fields, on hospital trains, at station hospitals, general hospitals, convalescent camps, dispensaries, laboratories, medical supply depots, and training centers; and to form medical personnel replacement pools, as well as for service with medical detachments assigned to tactical combat units.

The wide dispersion of our Army throughout the world requires proportionately more medical personnel than would be needed if our troops were concentrated in one principal theater of military operations, such as occurred in World War I. It is the responsibility of American medicine to see that these necessary personnel are made available.

The role of contemporary medicine in the current war effort is, indeed, a role of utmost importance which carries a responsibility of great magnitude. It calls for the maintenance of the health of civilian populations, especially industrial workers, and it demands adequate care for the health of our Army and Navy at home and abroad, for this is a war of annihilation or survival. Without conservation of our fighting strength we cannot hope to preserve civilization.

THE ARMY'S MEDICAL FIELD SERVICE SCHOOL AND ITS WAR TRAINING OF MEDICAL OFFICERS

COLONEL EDGAR ERSKINE HUME, MEDICAL CORPS, U. S. ARMY
CARLISLE BARRACKS, PA.

THE most extensive and most important work in the training of American medical officers for field duty in the present war is being done at the Medical Field Service School at Carlisle Barracks, Pa. At one of the Army's oldest and most historic posts there are being trained thousands of medical, dental, veterinary, sanitary, and medical administrative officers for the greatest war effort our country has ever had to put forth. Under the pressure of necessity, the efforts of a faculty of selected officer instructors are bent toward giving as much field training to as many officers as the military situation permits. We have many medical men in service. We need many more. Training goes on without cease, for there is ever the consciousness that no amount of money, no gifts of a generous and frightened Congress can buy us yesterdays. We have everything now needed to create a winning Army, save time. But even without as much time as we should like we can do great things with the fine officers and men who are flocking into the Army's Medical Department. We can overcome even the handicap incident to curtailed periods of instruction and turn out the men who will play the Medical Department's role in the winning of the victory.

WHY SHOULD AN ARMY HAVE MEDICAL OFFICERS AND MEDICAL SOLDIERS?

An unthinking person may feel that the only duty of a medical officer of the Army is to treat the sick or wounded man when brought to him for that purpose. Were this true, the Army would need no medical service at all. It would merely be necessary to employ civilian physicians and surgeons from time to time whenever and wherever needed. It is to be feared that some medical men otuside the military service are of this opinion.

But, unfortunately, it is not so simple. The Medical Department has many functions, all of which grow out of its great task *To Conserve Fighting Strength* —words which constitute the motto of the Medical Field Service School. It is our duty to select for the military service only those men who are physically fit for the duties expected of them, and thereupon, having admitted them, to keep them fit. Preventive medicine, in other words, is more valuable to the Army than is curative medicine, important though the latter is. Wars are won by men and not merely by machines. No matter how highly developed become our aircraft, our tanks, our submarines, and the rest, it is the human factor in the end that wins or loses wars.

Morale is an intangible thing, but one of supreme significance to the soldier. It is like the temper in the Damascus blade. Soldiers with high morale win

through to victory. Soldiers of poor morale have lost the battle before it begins. This is especially true of the officers, for officers with low morale cannot inspire their men to do deeds of military valor. Everyone knows the old adage that an army of lambs led by a lion is better than an army of lions led by a lamb.

All this is by way of stressing the importance of the Medical Department in the maintenance of morale. Fighting men must feel that if they are wounded or ill they will receive adequate medical care. They are encouraged and heartened by the knowledge that the medical soldier and the medical officer will accompany them right into action. There is no place that the infantryman goes, for instance, that the medical soldier does not go. Officers of the line have a way of telling their men that when frightened—and all soldiers are frightened at times—it is a good idea to fire in the direction of the enemy. Somehow this renews courage. It is the good old American spirit of striking back. Even though the riflemen may know that the chance of his hitting one of the enemy is small, he is nonetheless cheered by his ability to strike a blow.

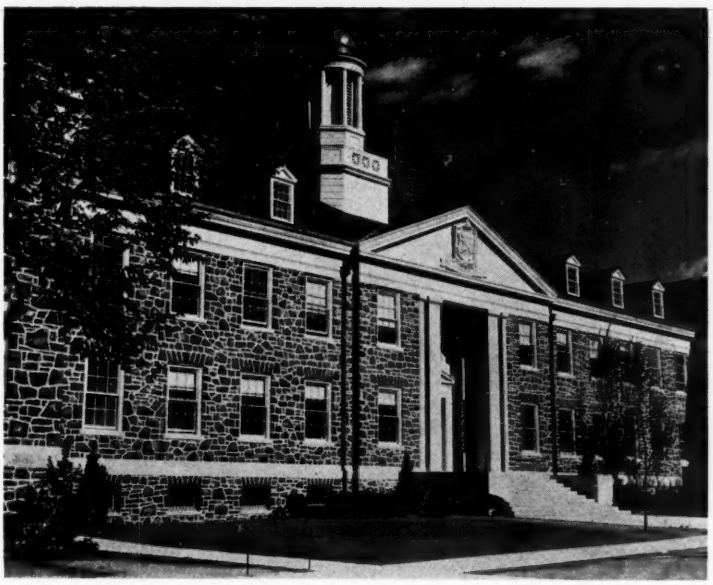

Fig. 1.—Hoff Hall, Medical Field Service School, Carlisle Barracks, Pa. Principal academic building. (Photograph by U. S. Army Signal Corps.)

But the medical soldier cannot do this. He is unarmed. His task is to care for the wounded men in action; he has no rifle with which to fire at the enemy. Only under rare conditions are medical soldiers armed; only, in fact, under the Geneva Convention, when it is necessary for them to defend wounded in their care. It takes a high order of courage for the unarmed man to stand up under the fire of the enemy and hold his ground. But that is exactly what our medical soldiers have always done.

Thus not merely from the humanitarian side is the Medical Department of the United States Army needed. As a morale builder it is a positive asset to the Commander-in-Chief. All this is taught the students at the Medical Field Serv-

ice School, but it is all predicated on our having thoroughly trained medical officers and men and military as well as medical training.

CARLISLE BARRACKS NOT A REPLACEMENT CENTER

The Medical Field Service School, Carlisle Barracks, is not a school for the training of medical soldiers; that is, enlisted men of the Army Medical Department. Its job is essentially one of training Medical Department officers, though a short course for selected noncommissioned officers is offered annually in time of peace. There are conducted, also, classes for enlisted Sanitary Technicians, of approximately one month each.

The task of Carlisle Barracks is "train the trainers." Many officers trained there are sent to the Replacement Centers where they assist in training the enlisted men. The Army maintains several such training centers: Camp Pickett, Virginia (formerly at Camp Lee, Virginia); Camp Grant, Illinois; Camp Barkeley, Texas; and Camp Joseph T. Robinson, Arkansas.

THE MEDICAL DEPARTMENT'S RECORD IN THE FIRST WORLD WAR

One may judge the future only by a knowledge of the past. We are engaged now in the most stupendous struggle that our land has ever known. Everything that we are and everything that we have is at stake. We at the Medical Field Service School are bending our every effort to impress upon the officers and officer candidates who take the various courses of instruction, the fundamental fact that they form an essential cog in the mighty military machine. They have before them the record of our service in other wars, particularly the first World War. Here are a few significant facts pertaining to that war:

> The first American wounded was a Captain of the Medical Corps; the second was an Army nurse. The first American killed was an enlisted man of the Medical Department. We have named one of our buildings Tugo Hall in his honor. The first American Army unit to reach Europe was a medical unit. The last to leave when we withdrew from the occupation of Germany was a medical unit. One may see the flags of these two units hanging side by side in the Army Medical Museum in Washington. Our battle death rates were higher than those of the Aviation, Cavalry, Engineers, Ordnance, or Quartermaster Corps. Those with a higher percentage than ours were the Infantry, the Tanks, the Artillery and the Signal Corps (the last but a fraction higher than the Medical Department).

These facts are eloquent. They show that while the Medical Department is what is sometimes called a "noncombatant service" (a misnomer for there is no such thing as a "noncombatant" in modern war), we, nevertheless, bear our proportionate share of danger. The missiles of the enemy do not discriminate, and the wearing of the red cross of the Geneva Convention is scant protection, as the foregoing data show. It must be remembered, too, that the soldiers with medical training go forward with the first elements of the advancing troops. And in withdrawals, some of which occurs in all wars, it is the medical unit that is the last to leave. Its duty in the place of danger is long.

MILITARY MEDICINE IS A SPECIALTY

Military medicine is a definite specialty, just as is ophthalmology or any other branch of medical science. It has its literature, its special practitioners,

and its ethics. It also has its handicaps, particularly one which does not affect any other medical specialty. This handicap is that in the past there has ever been a tendency for military medical officers to forget the lessons learned in the fierce light of warfare. Then, when once more war comes upon us—for there has always been a "next" war—it is necessary to learn military medicine anew, again in the hard way. The only practitioners of military medicine available have been the members of the small Medical Corps of the Regular Army and the medical officers of the National Guard and the Organized Reserves. These officers have been few, indeed, compared to the great number needed for war duty.

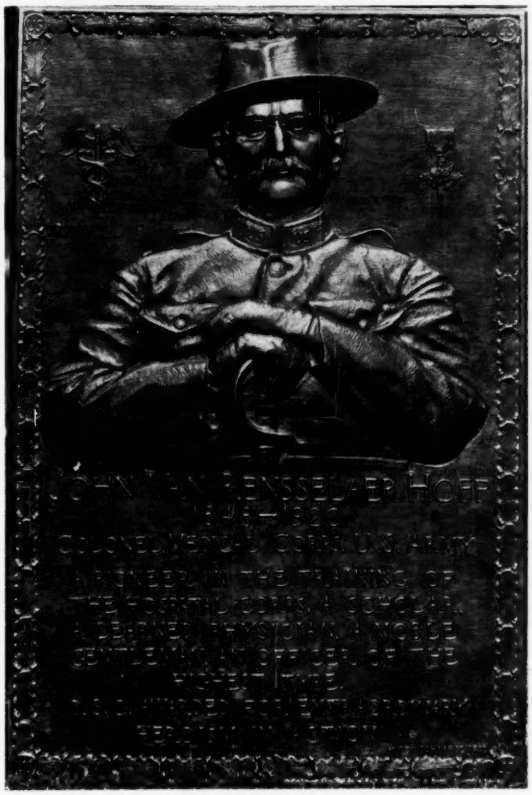

Fig. 2.—Bronze plaque in honor of Colonel Hoff. Placed within Hoff Hall, this tablet by the Gorham Company recalls a gallant medical officer's great contributions to training for field service.

DEVELOPMENT OF SCHOOLS OF THE ARMY MEDICAL DEPARTMENT

Nearly eighty years ago a wise Surgeon General, William Alexander Hammond (1828-1900), conceived the idea of forming an Army medical school in Washington, at which medical officers of our Army might receive preliminary instruction to fit them for their duties. He realized, as have all medicomilitary administrators, that the medical officer needs something in the way of training in addition to what he is taught at his medical school. Hammond went so far with his brain child as to select the professors, prepare the classrooms, and outline the curriculum. But his plans were disapproved by the Secretary of War. Mr. Stanton, who was his bitter personal enemy, finally had him tried

by court martial on a technical charge that resulted in his dismissal from the service. Years later Hammond was exonerated, but the Army Medical School had to await the advent of a more liberal Secretary of War.

Thirty years passed and the Surgeon General was the brilliant George Miller Sternberg (1838-1915), America's pioneer bacteriologist. Sternberg was more fortunate in the Secretary of War under whom he served, for Mr. Lamont approved of his plan to create the Army Medical School, so that in 1893 that institution came into being. It continues in its highly useful and protean work, filling a place that no other American institution occupies. The late Professor William Henry Welch (1850-1934) had a basis for calling it "America's oldest school of preventive medicine."

The Army Medical School has always given its students splendid training in certain techniques not ordinarily stressed, or considered only briefly, in the average medical school in the United States. Such work has included tropical medicine, helminthology, protozoology, advanced ophthalmology, and so forth. There used also to be found time to give a little practical instruction in drill, in equitation, and in field exercises. Such practical work was given in the grounds of the Walter Reed General Hospital or at Fort Myer. The Army Medical Center was not then contemplated, for the Army Medical School was miles away from the Walter Reed General Hospital, usually in rented quarters in downtown Washington. These arrangements were in effect until the end of the first World War.

In that great conflict medical officers once more learned military medicine, this time on a large scale. Contacts with medical officers of our allies, duty in far distant and hitherto unknown scenes, and highly specialized work, all had their broadening effect on American medical officers. When the war came to an end we had a highly efficient group of medicomilitary specialists in the Army. Then the huge army—at least it was huge by first World War standards—was demobilized. The Regular Army returned to its small size. The National Guard went back to the several States, and the Organized Reserves once more attempted to maintain a paper army and keep it trained with occasional periods of active duty in the summer, never more than a fortnight in extent. Had there been no other plan devised for keeping alive the lessons of military medicine bought at the cost of blood and human suffering, we would have been once more without any preparation when the second World War came upon us. But once more an able Surgeon General saw a way not only to keep alive what had been learned, but also to add to this sum of knowledge. That officer was Major-General Merritte Weber Ireland.

Surgeon General Ireland realized that thorough as was the training at the Army Medical School, that as essential as it is to the equipment of every medical officer of the United States Army, something more was needed. Fortunately for General Ireland's plan and fortunately for the Medical Department of the Army, there was already under the direction of the Surgeon General an ancient military post which was exactly what was needed. This was Carlisle Barracks, in the town of Carlisle, in the fertile Cumberland Valley of Pennsylvania, a hundred miles or so north of Washington. Carlisle Barracks was being used for General Hospital No. 31, devoted to reconstruction of disabled soldiers. It was

ideally located and all that was needed was for it to be turned over to the Surgeon General for permanent use as a training school for field duties of medical officers.

Accordingly, General Ireland addressed the following letter to the Secretary of War, through the Adjutant General of the Army:

"War Department
Office of the Surgeon General
Washington

April 28, 1920

"From: The Surgeon General.
"To: The Adjutant General.
"Subject: Medical Department Field School, Carlisle, Pa.

"1. I request that the U. S. Military Reservation at Carlisle, Pennsylvania, be permanently assigned to the Medical Department for use as a field school. Such a special service school is an urgent need in order that this department may comply with the policy announced in paragraphs 14, 15, 16, 29 and 30, G. O. 112, W. D., 1919.

"2. Facilities including construction exist at this post which may be converted to our needs in field training. Within two days by marching the prepared camp sites of the Gettysburg field are available. The use of adjacent mountain terrain for exercises has been offered to the Medical Department by a local townsman. The climate at Carlisle is such that alternation of season is found without undue extremes of heat and cold. The indoor season to be expected does not exceed three months.

"3. The need for the hospital at Carlisle will ultimately cease and the organization there will be listed for abandonment. If I understand correctly the use of this old post is not included in any General Staff plan for the future. I have considered, therefore, that the reservation could become available immediately and that there is no obstacle to its assignment to the Medical Department for field training purposes. Anticipating asking for a decision in this matter I have had made a preliminary survey of the site as to its suitability for this school. The results of this survey indicate that the selection will be an excellent one.

"4. It is my desire to have this school available about June 1 at which time a number of reserve officers and the present class of the Army Medical School would constitute the first class. In view of the urgency of this matter and the need of making arrangements for the abandonment of the hospital the earliest possible action is requested.

M. W. Ireland, Surgeon General, U. S. Army."

The Adjutant General of the Army, acting for the Secretary of War, indorsed the letter, under date of May 15, 1920:

"1. Upon the discontinuance of the United States General Hospital No. 31, the Medical Department is authorized to utilize for Medical Field School purposes the Carlisle Barracks Military Reservation, Penna., and the acreage adjacent thereto now occupied and controlled by the War Department by virture of permit from the Secretary of the Interior, dated August 22, 1918.

"2. The expenditure of funds by the Medical Department for the benefit of U. S. General Hospital No. 31, or the proposed Medical Field School, will be confined as closely as practicable to the territory contained within the boundaries of the Carlisle Barracks Military Reservation:

By order of the Secretary of War: G. H. Davis, Adjutant General."

Thus was born the Army's most important training center for medical officers in time of war. It has more than twenty-two years of efficient work to its credit and it has amply justified its inception. The post at which the Medical Field Service School was established is one of the oldest and most historic military reservations in our country. It merits a brief discussion of its history.

HISTORY OF CARLISLE BARRACKS

Carlisle Barracks was established in 1758 by the British Army, as shown by the "Military Papers" of Colonel John Stanwix, in the British Museum.

Stanwix was the first commanding officer of this post, established during the Seven Years' War, which was known in America as the French and Indian War. The British and Colonial troops occupied the present post during the long-continued hostilities with the Delaware Indians and other tribes. During the American Revolution, the Continental Army used Carlisle Barracks as a depot, and from there supplies and munitions were distributed. Hessian prisoners of war built the stone guardhouse at Carlisle Barracks; it is still standing and was until recently used for the purpose for which it was constructed. A School of Artillerists, probably the first school in the history of the United States Army, was established at Carlisle Barracks, 1778.

Fig. 3.—Temporary buildings at the Medical Field Service School. These are a few of the buildings for classrooms and barracks used for the accommodation of the large classes for officers and officer candidates at Carlisle Barracks, Pa.

American independence achieved, Carlisle Barracks was in the charge of the Ordnance Department of the Army, with the added function of being a recruit depot. During the Whisky Rebellion, in 1791 and 1792, President Washington sent an expedition, commanded by "Lighthorse" Harry Lee, father of General Robert E. Lee, against the four rebellious Pennsylvania counties. Carlisle Barracks was appointed the rendezvous for the Army. Some 10,000 to 15,000 troops were encamped on "the extensive common at Carlisle." President Washington came himself to Carlisle in the crisis of the rebellion, which was finally settled without bloodshed. At the time of the War of 1812 the old buildings used for the manufacture and storage of powder and shot during the Revolutionary War were reconditioned for the same purpose. When this second war with the mother country was at an end, a garrison, including both infantry and artillery, was continued at Carlisle Barracks.

In 1838 the War Department converted Carlisle Barracks into a recruit depot under the direction of an officer of dragoons. Here, in effect, was the Army's first cavalry school. At Carlisle Barracks, then, between 1838 and the outbreak of the Mexican War, were trained cavalrymen. From the post mounted units, both artillery and cavalry, departed for the southern theater of war. After that war the command at Carlisle Barracks devolved on Colonel Philip St. George Cooke, of the First Dragoons, a Virginian and General J. E. B. Stuart's father-in-law, who was destined to serve as a Union officer in the sixties. Shortly thereafter, a severe epidemic of cholera broke out, brought in, it was thought, by soldiers returning from Mexico. The post was quarantined, and the disease did not appear in the nearby town of Carlisle. Until the dark days of the War of 1861-1865 the post of Carlisle was typical of the United States Army station of the period, with the usual problems, vicissitudes, and development.

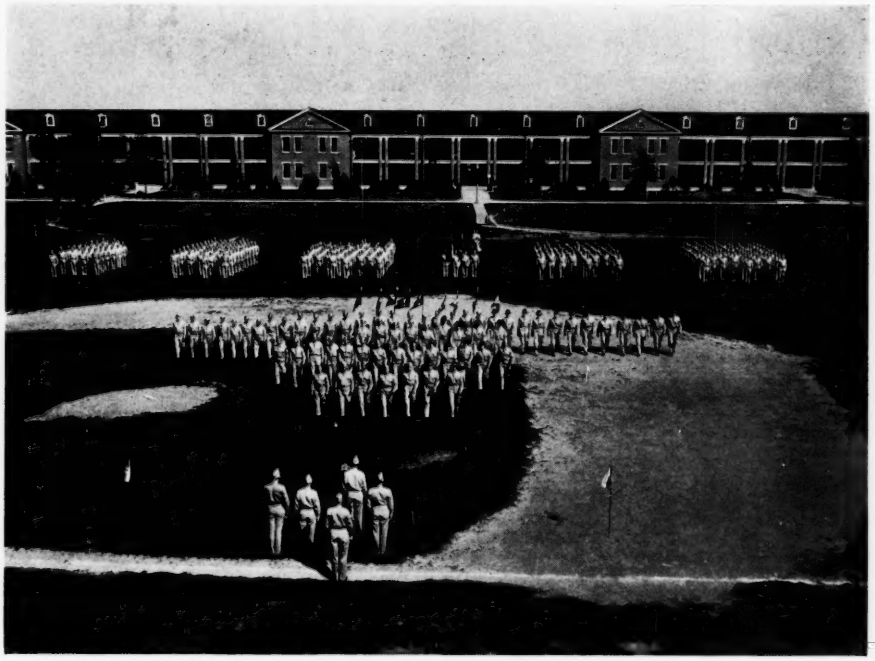

Fig. 4.—Parade of medical troops, Carlisle Barracks, Pa. Barracks of the 32nd Medical Battalion in background. (Photograph by James R. Gouffer of the *Evening Sentinel* of Carlisle.)

In the War Between the States, Carlisle Barracks became a supply center, as it had been during three previous wars. In 1861 it was the headquarters of the Mounted Recruiting Service of the United States Army. It not only saw the drilling of men recently taken into the service but also served as a place in which units withdrawn from the front were reconditioned, allowed to rest, and once more brought up to their strength. The fortunes of war were such that Carlisle Barracks was occupied by the Confederate troops, and General Fitzhugh Lee burned the buildings, with the exception, says a persistent tradition, of the quarters occupied by a West Point classmate. Thereafter, the post was rebuilt in part and surrounded by a wall within which drafted men were kept during their training. The war finally over, the post once more settled down to peacetime routine.

A part of the Sixth Cavalry was sent to Carlisle Barracks after the War. In 1867 it was suggested by the Surgeon General that selected enlisted men be trained as veterinary surgeons, and that the veterinary service not be placed under the Surgeon General, as the commanding officer of Carlisle Barracks had recommended. Thus a school for veterinarians was established at Carlisle Barracks. In 1871 the garrison of the post was ordered elsewhere, and for a time the post was closed, despite the pleas of the townsfolk of Carlisle. Matters dragged on until 1875, when Lieutenant Richard Henry Pratt (1840-1924), an officer deeply interested in the education of the Indian youth, established, under the authority of the War Department, the Carlisle Indian Industrial School. The Secretary of the Interior, Carl Schurz, gave it immediate support. Pratt, who ultimately rose to the rank of Brigadier-General, continued the direction of the Indian School until it closed in 1918. It made a splendid record during its nearly four decades of existence and achieved its objectives. The prowess of its students on the athletic field made it known to many who would not have been interested in the more serious side of its work.

In 1918 the War Department established General Hospital No. 31 at Carlisle Barracks, placing it under the command of Colonel (later Brigadier-General) Frank Royer Keefer, Medical Corps. The hospital did not actually begin to function until January, 1919, since much time was required for the conversion of the dilapidated buildings to hospital use. The institution became a reconstruction hospital wherein patients mutilated in the war not only were given adequate treatment but also were taught trades.

Before General Hospital No. 31 closed, Surgeon General Ireland requested the Secretary of War to assign Carlisle Barracks permanently to the Medical Department for use as a field school. This was done (see above) and the Medical Field Service School came into being on Sept. 1, 1920, the day that General Hospital No. 31 ceased to exist. The officer assigned as first Commandant was Colonel Percy Moreau Ashburn, Medical Corps. He was succeeded in 1923 by Major-General (then Lieutenant-Colonel) Charles Ransom Reynolds, who directed the school for eight years. His successors have been Brigadier-General Edward Lyman Munson (1931), Colonel Garfield Lesly McKinney (1932, acting), Brigadier-General Matthew Augustus DeLaney (1933), Brigadier-General Major Augustus Wroten Shockley (1935), Colonel Herbert Charles Gibner (1937), Brigadier-General Roger Brooke (1940), Brigadier-General John Mitchell Willis (1941, acting), and Brigadier-General Addison Dimmitt Davis, who has been Commandant since June, 1941.

THE FIRST FACULTY

The first faculty of the Medical Field Service School (1920) was composed of the following officers: Colonel Percy Moreau Ashburn, Commandant; Lieutenant-Colonel James Lung Bevans, Assistant Commandant; Captain Herbert Wellington Taylor, Secretary; Major Leon Connallin Garcia, Director of the Department of Administration; Captain Herbert Wellington Taylor, Director of the Department of Military Art; Major George Burgess Foster, Jr., Director of the Department of Field Sanitation; Major John Pierrepont Fletcher, Director

of the Department of Logistics and of the Medical Equipment Laboratory; Major Joseph Edward Bastion, Director of the Department of Enlisted Training and Commander of Demonstration Troops; and Captain Guy Blair Denit, in charge of Correspondence Courses. Many of these officers served at the Medical Field Service School for several years, and many of them have returned more than once for subsequent duty.

In 1923 Lieutenant-Colonel Charles Ransom Reynolds was appointed Commandant of the school, and to him is due its development and attainment of its important place in our scheme of military education. He served for eight years in this position of great responsibility, during which time he became known to nearly all medical officers of the National Guard and Reserves as well as those of the Regular Army. He became Surgeon General in 1935 and retired in 1939 to accept the directorship of the Bureau of Tuberculosis Control of the Commonwealth of Pennsylvania. Since General Reynold's administration of the Medical Field Service School no Commandant has served for as long as four years, due to the exigencies of the military service.

EXPANSION AND PROGRESS OF THE MEDICAL FIELD SERVICE SCHOOL

The Medical Field Service School, established as we have seen through the wisdom of the Surgeon General and the talents and hard work of its early faculty, did not spring fully developed into its present state. It was a gradual process, marked by many handicaps and delays. Instituted at the close of the first World War, it was given comparatively little financial support by the Congress of a war-weary nation. The most essential supplies were hard to get, and so short was the list of personnel that most of the officers had to occupy several positions simultaneously. It took good management, economy, and wise planning to keep it going. But those things it had, so that it passed through the hard times and was ready for the immense burden thrown upon it when the national emergency of 1940 arose. It was prepared for its present stupendous task of preparing the medical profession of the land for its part in the greatest war and the greatest danger that the United States has ever known.

Year after year the successive Surgeon Generals tried to obtain an appropriation for a new and adequate academic building at Carlisle Barracks. The school building first used was one of those built more than a half a century ago for the use of the Carlisle Indian Industrial School (1889). It was inadequate as to size, arrangement, and location. Finally, it was found to be actually unsafe, and the Secretary of War ordered it pulled down. Over the week end, for the matter was declared urgent, the old building was evacuated and the school was temporarily set up in the old gymnasium (1939). It was a matter of pride that not a day's instruction was lost in this wholesale change. But still no funds for a new building were forthcoming.

At length Congress in 1940 appropriated $375,000 for a new academic building (Public 661, 76th Congress). Work on its construction began without delay and it was completed in 1941. The cornerstone was laid with appropriate ceremonies on June 26, 1941, by the Surgeon General, Major-General James Carre Magee. It was occupied by the Medical Field Service School on Oct. 6, 1941.

Thus when the emergency preliminary to the outbreak of the second World War was declared, the building was ready and has continued to serve as a nucleus of the school. With the enormous classes now being put through the school, it is, of course, inadequate in size, but with the temporary buildings constructed as classrooms there is sufficient space for the needs of the school.

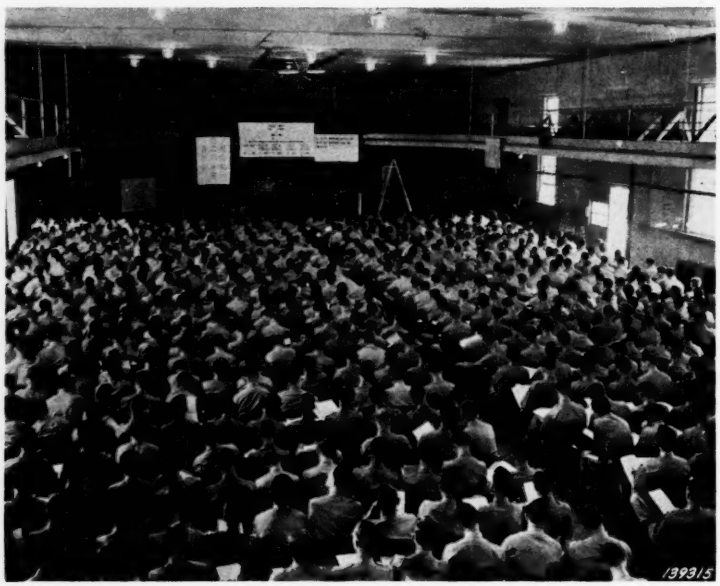

Fig. 5.—Officers class in medical tactics, Medical Field Service School, Carlisle Barracks, Pa. The school uses Tugo Hall, the gymnasium, for some of the large classes now under instruction. This building is named for Private Oscar C. Tugo of Boston, the first American soldier killed in the first World War. He was an enlisted man in the Medical Department. (Photograph by the U. S. Army Signal Corps.)

The academic building bears the name of the building that preceded it, Hoff Hall, named for Colonel John Van Rensselaer Hoff (1848-1920), pioneer proponent of adequate education in field duties for medical officers and enlisted men. On the cornerstone of Hoff Hall are carved words of a great British churchman, words that are as true now as when he wrote them nearly three centuries ago:

> "To Preserve a Man Alive in Midst
> of Chances and Hostilities is as
> Great a Miracle as to Create Him."
> *Jeremy Taylor.*

OBJECTS OF THE MEDICAL FIELD SERVICE SCHOOL

The objects of the Medical Field Service School are thus set forth in Army Regulations:

a. To instruct and train Medical Department officers of the Regular Army, National Guard, and of the Officers' Reserve Corps in the principles and methods of medical field service so as to increase their ability as instructors and to enhance their proficiency in the performance of their command and staff duties.

b. To instruct and train selected enlisted men of the Medical Department of the Regular Army, National Guard, and Organized Reserves in the duties of noncommissioned

officers pertaining to the organization, mobilization, training, and operation of Medical Department units of the components of the Army of the United States.

c. To act as an agency of the Surgeon General in the development and perfection of the principles and methods of medical field service.

d. To assist in the development of medical field sanitary equipment; to assist in the preparation and revision of Medical Department Training Regulations, instruction manuals, and other publications; to make research in matter pertaining to the field duties of the Medical Department; to disseminate to the service information pertaining to instruction and training used and developed at the Medical Field Service School.

It will be observed that these paragraphs from the "Army Bible" concern chiefly the Army as it exists in time of peace. Now that we are at war, the fundamental principles underlying the teaching at the Medical Field Service School have not changed, but the activities of the school have been largely directed in more specialized channels. There is no longer the division of the Army of the United States into the Regular Army, the National Guard, and the Organized Reserves, so that the instruction afforded at Carlisle Barracks is for all officers without distinction as to component of the large Army of the United States.

The teaching has naturally become much more elastic now than in days of peace. The curriculum has had to be radically changed several times, depending on the number of officers and others in each class, the period of time available for their instruction, the special duty to which the officer is destined by the War Department, the space available for teaching purposes and for quarters at Carlisle Barracks, and other factors. As information is received as to the medical service in our own Army and in those of other countries, the teaching at the Medical Field Service School is changed accordingly.

COURSES OF INSTRUCTION

As at all military schools, several courses of instruction are offered at the Medical Field Service School. Their nature and extent have been changed from time to time, depending on what military men call exigencies of the service. Prior to the declaration of the present emergency by the President, the following courses were being given at Carlisle Barracks:

Basic Course: This course was planned for junior or newly commissioned officers of the Medical Department of the Regular Army. It began early in January and normally was six months.

The National Guard and Reserve Officers' Course: Field officers (i.e., colonels, lieutenant-colonels, and majors) and senior captains of the Medical Department of the National Guard and the Officers' Reserve Corps attended for six weeks.

Advanced Course: Field officers of the Medical Department of the Regular Army, the National Guard, and the Officers' Reserve Corps received instruction for approximately three months.

Noncommissioned Officers' Course: This course, of approximately eight weeks' duration, beginning about September 15 each year, was provided for selected men of noncommissioned grades of the Regular Army, the National Guard, and the Organized Reserves.

Besides these formal courses at the Medical Field Service School, the three following types of summer camp were organized for instruction of officers and potential officers of the Medical Department of the Army:

Unit Training Camp for Reserve Officers: The officers receiving this instruction were, for the most part, assigned to medical units, though a few additional officers have been attached to the personnel of such a unit for the period of the camp. The units for which officers were so trained included medical regiments, medical squadrons, medical battalions, general hospitals, evacuation hospitals, surgical hospitals, and hospital centers. This camp has usually been of a fortnight's duration, beginning early in July of each year. Since the declaration of the existing limited emergency, this type of camp has not been conducted. Approximately 350 officers have been trained each year at this camp.

Basic Summer Training Camp for Reserve Officers: The instruction given in these annual camps, which also have been of two weeks' duration, has consisted mainly of basic military objects, including the employment of medical detachments and Medical Department units, Medical Department administration, mobilization, and sanitation. The chief objective of this camp has been to prepare the officers trained for more advanced instruction. Approximately 200 officers have enrolled in this camp annually.

Reserve Officers' Training Corps Camp: Here the course included instruction in the functions and activities of the Medical Department from the viewpoint of the enlisted man. The instruction included drill, function, and activities of medical detachments and of the medical battalion, squadron, and regiment, and general principles of sanitation, particularly in the field. The work at the R. O. T. C. camps supplemented that given by regular assigned instructors at various medical schools, and their instructors accompanied the students to the camp. The R. O. T. C. camps at Carlisle Barracks included 400 to 500 men each year and did not differ from similar medical R. O. T. C. camps elsewhere. At the camp held at Carlisle Barracks in 1941 the usual number of men were enrolled. The students successfully completing the full four years of Reserve Officers' Training Corps training were given reserve commissions in the Medical Corps of the United States Army.

Officers' Courses: The President's declaration of the existence of a limited emergency on Sept. 8, 1939, and of an unlimited emergency on May 27, 1941, changed the type of instruction offered at Carlisle Barracks, just as it did at other Army schools. There was no longer time to devote six months or more to a regular basic course; and the same was true of the other courses. A pressing need developed for training as large a number of officers of the Medical Department as could be and in as brief a time as possible. Therefore, a decision was made to establish courses of approximately one month each, known as *Refresher Courses.* The name was unfortunate, being borrowed from a type of course offered at some of the Army's other schools, designed for senior officers who needed a brief review. The new courses of Carlisle Barracks were attended largely by newly commissioned officers or those who had had little or no military experience, so that the courses were hardly "refreshers"; they were given to men who needed, and received, new information. This course is now known as the Officers' Course.

There were seven of these one month "Refresher" Courses given at the Medical Field Service School, beginning December, 1940. It was then decided that such brief courses did not permit sufficient training for the student officers, and so hardly justified their attendance. The period of training was, therefore, increased to two months, beginning with the course that opened on Sept. 2, 1941. Since then five two-month classes have been graduated, but the pressure of necessity then made it necessary to graduate five more of the one-month classes as well. Beginning in January, 1943, provisions for six-week courses will become effective.

Fig. 6.—Demonstration of work of medical soldiers in battle, Medical Field Service School. (Photograph by the U. S. Army Signal Corps.)

Officer Candidate Courses: Since the Medical Department of the Army has great need for officers to aid in its administration, but who need not hold medical, dental, or veterinary degrees, there was created the Medical Administrative Corps. Each Medical Administrative Corps officer releases a medical, dental, or veterinary officer for professional work, since the administrative functions would otherwise have to be performed by professionally trained officers. Any enlisted man of the Army who has had the minimum thirteen weeks' basic training may be recommended for admission to the Officer Candidate Class at the Medical Field Service School. Recommendations by the man's immediate commanding officer are based on his character, education, leadership, and other qualifications for commissioned rank. The Officer Candidate Course is three months in length. One group is admitted each month and one is graduated, so that a beginning, an intermediate, and a senior group are under training. A large proportion of the members of the Officer Candidate Classes are college graduates, and not a few hold professional degrees in law, engineering, or other nonmedical professions. Thirteen of these courses have been, or are being, held. This course in the future is to be given at the Medical Replacement Center at Camp Barkeley, Texas, will be related below.

Cadre Course: This course of one month's duration is designed to train medical officers being assigned to newly created divisions of the Army. Thought is given to the special needs of such officers, part of whose instruction is therefore different from that of the members of the regular officers' classes.

Medical Inspectors' Course: A one-month course for selected officers in field sanitation and preventive medicine. It is specially designed, as its name indicates, for officers who are to serve as medical inspectors, who correspond in duty somewhat to civil health officers.

DEPARTMENT OF THE MEDICAL FIELD SERVICE SCHOOL

The work of the Medical Field Service School is different from that of any other type of school that its students have known. It is so little understood by the public, that a consideration of the several departments is desirable. It will be observed that the school does not concern itself with the teaching of clinical medicine or with laboratory procedure. Such subjects are more properly taught at the Army Medical School and at its sister institution, the Walter Reed General Hospital, both at the Army Medical Center in Washington. The work of the Medical Field Service School and that of the Army Medical School is so arranged and coordinated by the Division of Training of the Surgeon General's Office that there is no conflict. There is likewise no conflict with the work of the School of Aviation Medicine at Randolph Field near San Antonio, Texas.

The officers in charge of the several departments of the Medical Field Service School have cooperated with me in preparing the following detailed statements, which have likewise been checked by the Assistant Commandant. The Assistant Commandant is in direct charge of the instruction given at the Medical Field Service School. His function is similar to that of a dean of a college or university.

Department of Military Art.—The mission of this department is the instruction of Medical Department personnel in the principles of medical support of combat operations. To this end, there are taught the basic principles of warfare, the military policy of the United States, the organization, tactics, and combat dispositions of the basic arm of the service, the Infantry, and the supporting arms and services, the Artillery, Cavalry, Armored Force, Air Corps, Engineers, etc. Correlation and mutual support of these arms and services in coordinated action are taught.

With combat tactics as a background, students are taught the principles of medical support of attack, defense, and special operations, such as river crossings, landing operations, retrograde movements, and pursuit. Early in the instruction students are taught the use of military symbols, map reading, and practical application of maps to terrain. Military maps include general, strategical, tactical, topographical, and photographic maps. Some of the exercises require close attention to orientation both in daylight and in darkness. Teaching methods include conferences, daily application terrain exercises, demonstrations, training films, map exercises, and examination.

Instruction is given in the preparation of medical and unit plans, preparation and use of standing operative procedure, and the formulation and issuance of combat orders to put plans into action. In addition to medical support of combat, instruction includes medical support of troops in bivouac and on the march.

The scope of the instruction in military art is such as to train medical officers in the principles of combat and the medical support thereof to such a degree that such officers can function efficiently under all conditions.

Department of Military Sanitation.—The old adage about the relative value of the ounce of prevention and the pound of cure is nowhere more true than in the military service. The Medical Department has the duty of treating sick and wounded soldiers. But it also has the far more important responsibility of keeping men well. To this end, all the teachings of preventive medicine and sanitation are used in the development of procedures designed for the maintenance of the soldier's health. In the field, in particular, modern sanitation is of the utmost importance. The course offered at the Medical Field Service School is designed to instruct students in the established practical measures for the preservation of the health of our fighting men. Thus, the prevention of disease is studied, not only as understood in our own climate, but in

Fig. 7.—Demonstration of the work of a medical battalion. The instructor (at right) uses charts and diagrams. The medical soldiers actually demonstrate the principles taught. This exercise is on Stark Field, the only spot in America where troops have been drilled for every American War. (Photograph by the U. S. Army Signal Corps.)

the various other climates in which our forces may be sent by the exigencies of modern war in all its world theaters. Stress is placed on control measures against communicable diseases of military importance, including venereal diseases. Students are taught how to construct and maintain field devices and apparatus for the purification and safeguarding of water supplies, for the disposal of body and other waste, for the preservation, transportation, and preparation of food, etc.

The "Sanitary Area" consists of full-size models of various devices used by troops in the field, such as incinerators, water sterilizers, and the like. The control of insect and other vectors of disease is an important part of the curriculum. For instance, officers and officer candidates are taught how to protect the soldier from flies, lice, fleas, mites, ticks, ants, bedbugs, mosquitoes, midges, roaches, leeches, rodents, and a host of other pests and vermin. Of particular

importance is special consideration of jungle sanitation, the sanitation of commands in desert country, and in the cold climates of the far north. Protection against snakes and other venomous animals is studied. The proper methods of conducting sanitary inspections are taught.

At first thought one may suppose that military sanitation is no different from sanitation in civil communities, *mutatis mutandis*. But this is not true. In the Army the military situation must ever be supreme. The health of the men is to be maintained though the medical or health officer may have no voice in the determination of the nature of that situation. A civil health officer may place a placard on a house wherein there is a case of a communicable disease. Thereafter to enter such a house is to violate the law, and punishment can be brought about by the health officer. The military health officer, on the other hand, cannot say merely that certain area or place is dangerous because it contains communicable disease. He cannot order soldiers, in other words, to keep out of a dangerous area. He may well know that a certain place contains malarial mosquitoes, but if the military situation demands that the commander take his troops through that area, through it they must go. A military health officer must, therefore, be prepared to tell his general how best to prevent the occurrence of malaria, even though he knows that the men must be exposed. Our Department of Military Sanitation has not only to review the general principles and practices of sanitation, but also must teach its students how to make the best of situations actually to be faced. Actuality, and not theory, must govern.

Department of Administration.—Bookkeeping and the maintenance of records are boring to the average person. "Paper work," as it is termed by military men is, however, recognized as a necessity. No business firm or other establishment can run without records of what it is doing, and without the proper keeping of accounts and returns. Administration in the military service has been greatly simplified, but a minimum remains and always will remain.

The instruction of the Department of Administration, therefore, includes all the military activities of the Medical Department save the tactical and technical employment of units or personnel. This broad classification includes the methods of the procurement of supplies and the accounting for them. Supplies may be those acquired by the Medical Department (which like the Engineer, Signal Corps, Ordnance, and Quartermaster Departments, is a "supply department") or those used by the Army in general. Thus, students are taught how to make out the required reports, requisitions, returns, and other administrative procedures necessary in the proper care and disposition of sick and wounded soldiers. This includes the administrative procedures incidental to the procurement and maintenance of shelter and food for patients and medical personnel necessary to care for them. Military law is taught by this department, for all officers must understand court martial procedure, since such duty is occasionally unavoidable. The proper relations between military and civil power must be made clear. The organization and operation of the important military units of the Medical Department are taught, such as the various types of military hospitals.

In the instruction by this department, accuracy and rapidity of accomplishment of administrative duties are stressed. A considerable part of the time allotted to the Department of Administration consists of applicatory exercises in which the student is presented with actual or simulated administrative situations of the types likely to be encountered in actual service. These problems he is required to solve in accordance with prescribed Army administrative procedures.

Those who may think that it is a waste of time, in these days when time is so precious, for officers and officer candidates to have to learn administrative procedures, must remember the ultimate importance of adequate medicomilitary records. It is the Medical Department which must be prepared to tell the commander of troops just how many men he actually commands. It means little for a general to command a division, for instance, which has a strength of ten thousand men "on paper," if he does not know how many of his supposed strength are fit to fight. If 10 per cent of his command be sick or otherwise noneffective, then he commands not ten thousand men, but only nine thousand. He has only one source for the information that is vital to him and to the military success of his force. That source is the Medical Department. The senior medical officer can tell him—but only if proper records are kept by all medical personnel.

In our country we have always been generous in the matter of pensions, bonuses, compensations, and the like for former soldiers. In the old days when medical records were incomplete or wanting, many men could not prove their right to Governmental financial aid. Some worthy men, therefore, were not given the money to which they were entitled by law. In other instances, men were able to obtain money to which they were not entitled, because of incomplete records. Thus, the Medical Department of our Army has a double duty in the matter of keeping correct and adequate records. It must protect the rights of the future veteran, and it must protect the taxpayer. Records, then, are of very great importance.

Department of Training.—The training of soldiers is one of the prime functions of officers in any branch of the Army. Soldiers are made not born. No man springs fully armed from the brow of the Goddess of Wisdom nor from the brow of the God of War. Yet he must have some of the knowledge of Minerva, the skill of Mars, together with the cunning of Aesculapius, if he is to be a good medical soldier. The Department of Training devotes its energies chiefly to teaching officers and officer candidates how to train the men in the ranks. Its courses are designed to familiarize students with the basic principles of military instruction and the manner in which such subjects may be imparted to enlisted men of the Medical Department. The curriculum includes lectures, conferences, and demonstrations, all used to orient the student as to the general and special conduct of military instruction in its several phases. For purpose of physical training and body coordination, a systematic series of drill and calisthenic periods are conducted.

The work in military training is designed to familiarize the student with the methods of instruction useful in, and appropriate to, the military service. The mechanism of teaching is shown, with consideration of such factors as the

emotional and psychological approach, as required in training the medical soldier for combat duty. Particular emphasis is placed on the use of the visual sense for instructional purposes, and following this, by the applicatory method.

Military courtesy is taught both for itself and as an aid to achievement of military discipline. Instruction is given in both indoor and outdoor courtesies. Stress is placed on the relations necessary between officers and enlisted men, between officers, honors, and courtesies rendered to the flag, the National Anthem, commanding officers, and at ceremonies.

The inspection is a necessary feature of army life, since standards to be reached and maintained must at all times be closely scrutinized by officers concerned. The proper mode of conducting inspections is taught, including inspection of barracks and tents, unit inspections, and inspections of the soldiers' equipment. The class itself is periodically inspected by the commanding officer, which serves a direct purpose and likewise an indirect one, since it teaches how such duty should be performed.

In the preparation of training programs and schedules, the students are taught how to make the most of the time available for training their men, ever with an eye to the need for the particular unit being trained. From the estimate or analysis (the British say "appreciation") of the situation, a program for training is developed, out of which, in turn, a systematic schedule is produced. A part of the class instruction consists of an illustrative problem which takes them through the several procedures mentioned. Emphasis is placed on progressive step-by-step training, continuity of subject matter, variation in methods of instruction and approach, and decentralization of effort in teaching. Such schedules are worked out in detail in the classroom, and discussion is encouraged.

Instruction is given also in the movements of dismounted drill by demonstration and group instruction, followed by student application of each movement. To overcome awkwardness and diffidence, the class conducts cadence drill in which members collectively give the commands to the unit. This is followed by a period of command exercises in which each officer individually is called upon to drill the unit. Emphasis is placed on the disciplinary effect of drill, its possibilities in teaching precision and teamwork, and the instillation of prompt response.

By means of conferences, demonstrations, and application, the classes are instructed in litter drill, ambulance loading, physical training, use of the Army leg splint, and the assembly and adjustment of the medical soldier's field equipment.

Department of Logistics.—Logistics is defined as "that branch of military science which takes cognizance of the comparative warlike resources and capabilities of countries between which war is likely to arise, as well as of all conditions it is likely to be conducted, such as the geographical features, climate, means of transit, food resources, etc., of a probable seat of war." The more narrow application of the term logistics implies the study of the movement of troops and supplies, with reference to the factors which affect such movements.

At the Medical Field Service School the student is taught how to operate, maintain, and employ the motor transportation assigned to medical detachments, battalions, squadrons, and regiments. The teaching also includes study in-

Fig. 8.—Demonstrations of the use of the wheeled litter. (Photograph by the U. S. Army Signal Corps.)

Fig. 9.—An operating table made by placing ends of the litter on two medical chests at the Aid Station. (Photograph by the U. S. Army Signal Corps.)

volving the intricate problems of supply of medical units, and the problems incident to the medical supply of all units in the field.

The matter of transporting medical personnel and medical material from one place to another is far from being as simple as it may appear at first thought. Without a knowledge of the broad problem, one might think that when one wishes to move medical units from point A to point B, one has merely to look on the map and find the nearest road connecting the two points and order the medical units to proceed over that road. But perhaps that obvious road may be under the enemy's fire; or perhaps it is being used by our own advancing infantry; or perhaps we have just learned that the bridges over which that road passes have been destroyed. Thus one must be prepared to find other roads or to move across country in some instances. It all involves not only a knowledge of the terrain, but up-to-the-minute knowledge of the military situation, where our own troops and those of the enemy are disposed, and full information as to the condition of our vehicles and of the roads. And many other factors besides. Logistics is not a simple subject.

Department of Field Medicine and Surgery.—A relatively new addition to the Medical Field Service School, having been created in June, 1941, is the Department of Field Medicine and Surgery. The department collects and evaluates current information as to medical service in the field, particularly during combat. This information is communicated to the students and other personnel of the school. New drugs, new types of treatment, and new apparatus are studied. Matters pertaining to the prevention and treatment of trauma and disease in forward battle areas—the divisional area in general—are included.

This department teaches officers of the Medical Department how to make the best use of the material available at a certain place and under certain conditions. The Medical Department rarely, if ever, has the choice as to such conditions. Officers must learn to carry on with what they have; they should not be helpless if they are not provided with every convenience to which they may have become accustomed in civil practice. In these days of modern hospitals with fully-equipped clinical aids, some of the resourcefulness and ingenuity of the older generation of practitioners has been lost. Such qualities are essential in the military service. On the field of battle the medical officer must be prepared to treat wounded men with the best emergency measures available. Treat them he must, whether or not his supplies have arrived, or whether or not they have been exhausted.

This department considers such matters as first aid at the site where the injury has been sustained; emergency medical and surgical treatment in the battalion, collecting and clearing stations; principles and practices in the use of plasma, human albumin, and human blood, wherever applicable; prevention and treatment of shock, hemorrhage, and infection; principles and practice of the triage or sorting of the wounded; chemotherapy in its application to field medicine; medical care of gas casualties; use of anesthetics in the field; use of personal protective equipment and devices in relation to the prevention of injury and disease; the physiology of wound healing and the emergency management of wounds; consideration of medical and surgical equipment, including sutures, ligatures, dressings, splints, medicaments, etc. The department sums up its

duties in the words: "The application of the best medical and surgical care of the greatest number of sick and injured soldiers at the front, with a minimum of trained personnel and material."

Department of Dental Field Service.—The prime duty of this department is the instruction of officers of the Dental Corps in the organization and functions of the Medical Department units, in order that such officers may accomplish their professional and administrative duties most effectively in both fixed installations and tactical commands. The course emphasizes the cooperation of medical and dental officers, and prepares the latter to serve as auxiliary medical officers when circumstances require.

The officers' classes at the Medical Field Service School include officers of each of the several corps of the Medical Department. Much of the instruction is given to the entire class. However, there are certain administrative functions of medical officers, for example, which do not apply to the Dental Corps, and vice versa. While the medical officers are being given such instruction, the dental officers are given, in separate classes, the work which applies to them alone. This arrangement has been found most satisfactory to all concerned.

Some of the special instruction afforded dental officers includes: duties of dental officers of all units, *Army Regulations* of particular interest to the Dental Corps, dental examinations and surveys, training of dental assistants, dental field equipment and treatment of jaw fractures in the field (with approved methods of splinting). The instruction in these various subjects is by conferences, applicatory exercises, and demonstrations.

Department of Veterinary Field Service.—This department furnishes, particularly to officers of the Veterinary Corps, essential information concerning the prevention of transmission to military personnel of the communicable diseases of animals. Thus special study is made of the protection of human beings from unsound food of animal origin (milk, meat, butter, eggs, cheese, etc.). Veterinary officers are given special instruction in medical field service, special emphasis being placed on the hospitalization and care of animals.

The special training afforded dental officers in their particular duties during periods when medical officers are receiving training not applicable to the Dental Corps, holds true also of the veterinary officers. While the medical and dental officers are each receiving special instruction not of interest to the other group, the veterinary officers are under the instruction of officers of the Department of Veterinary Field Service for special training necessary for their duties.

Among the special subjects taught by this department are: the preparation and rendition of the field veterinary reports and returns, together with other administrative work concerning animals; and the supply and inspection of food products. Other topics are the preservation of animal health, methods of preserving and storing foods of animal origin, veterinary aspects of chemical warfare, technical and tactical employment of veterinary units. Special attention is paid to the veterinary facilities with various arms and services. This last includes the care and treatment of animals under field conditions.

General Instruction.—Besides the teaching in the departments just outlined, special instruction is afforded in a number of special fields not directly connected with any department. There are lectures and conferences on such

topics as public speaking, consideration of medicomilitary problems of the past and present, notes on the medical services of the United States Navy, the United States Public Health Service, the Veterans' Administration, and that of various foreign armies.

Gettysburg is only about 28 miles from Carlisle Barracks, so that the classes, when time permits, are taken there for a tactical visit to the battlefield. There an officer explains the battle in detail, including the medical problems that arose. The battlefield of Gettysburg is used for map problems by every school in the United States Army, but only the Medical Field Service School is near enough to have teaching take place on the terrain itself.

Extension Courses.—The department of extension courses has the duty of preparing instructional material for use in the training of officers and enlisted men, particularly those of the Medical Department. The material prepared includes a lengthy series of Field Manuals, Technical Manuals, Training Films, Film Strips, and the Army Extension Courses. These training aids and texts include material on many phases of medicomilitary training. The data prepared by this department are distributed to the various posts and stations of the Army, and are utilized by officers and men in their training for war duties.

The series of correspondence courses formerly offered by this department is not being used under war conditions, since more extensive training is now permitted, and few persons not on active military duty would be interested in pursuing such courses.

Liaison Officers.—A modern army is a complicated machine. In order to understand the proper function of any of its parts, it is essential that the general working of other parts be thoroughly understood. It is like working a jigsaw puzzle. One must know the shape of the pieces already on the board before he can fit the piece in hand into the complicated mosaic of the whole.

To achieve this, the Medical Field Service School has several officers of other branches of the United States Army on its faculty. They teach the students the work of their particular branches and give information to other departments of the school on the technical and tactical side of their work. This system has been found most effective. There are medical officers, graduates of the Medical Field Service School, on duty at most of the other service schools of our Army. At the Medical Field Service School there are at present on duty as liaison officers, senior officers of Infantry, of the Armored Force, and of the Chemical Warfare Service. We are also highly fortunate in having a Colonel of the Royal Army Medical Corps of Great Britain, an officer of wide experience and training, who not only gives the greatest assistance in the teaching and the preparation of programs and plans, but also frequently visits medical installations in the field in many parts of the United States. He has been of great value in the work of the School. An officer from the Medical Field Service School has visited the Royal Canadian Army Medical Corps Training Centre at Camp Borden, Ontario, to study the work of that school and to give lectures on the work of the American school. Similarly, officers from the Canadian school have made visits to Carlisle Barracks for similar purpose. Such exchanges of visits will be continued.

Fig. 10.—Work of the Aid Station. Patients kept warm while data are recorded and preliminary examinations made. (Photograph by the U. S. Army Signal Corps.)

Fig. 11.—Work of a Battalion Aid Station. Demonstration at Carlisle Barracks. (Photograph by the U. S. Army Signal Corps.)

Contact with other branches of the Army and with the Medical Corps of the Navy and of the United States Public Health Service is readily maintained by means of visits of personnel to Washington, which is only a hundred miles distant.

PUBLICATIONS

The Medical Field Service School publishes three important scientific periodicals. They are all quarterly publications and they are all edited in the Surgeon General's Office, War Department. They are *The Army Medical Bulletin* (established 1921 and now in its sixty-fourth issue), *The Dental Bulletin* (now in its thirteenth volume), and *The Veterinary Bulletin* (now in its sixteenth volume). From time to time special texts are published. Such books are primarily for use in the instruction of the various classes at the Medical Field Service School. Other texts of wider application are used throughout the Army, and are often adopted as texts by schools and colleges not connected with the miltary service. Most recent of the latter class of books is *Elements of Military Hygiene*, the second edition of which is just off the press. It was written primarily for Cadets at the United States Military Academy, but it will doubtless have other general use.

Some of the material is issued in mimeographed form, but the greater part is printed. The Print Shop of the Medical Field Service School is now working twenty-four hours a day and is turning out an immense volume of material. The *Army Medical Bulletin* has a circulation of nearly 20,000; the *Dental* and *Veterinary Bulletins* have somewhat less.

The Book Shop of the Medical Field Service School sells the publications for practically cost to persons not students. Students are issued all necessary texts without cost.

The Art Department of the School prepares military maps, sketches, charts, diagrams, overlays, and the like, for use in connection with instruction. Such material is often issued in large quantity.

NUMBER OF GRADUATES OF THE MEDICAL FIELD SERVICE SCHOOL*

COURSE	DATE COURSE FIRST GIVEN	NUMBER OF GRADUATES
Basic Course	1920	1,369
Advanced Course	1921	217
Field Officers' Course	1923	273
Officers' Course (formerly Refresher Course)	1940	6,838
Special Cadre Class	1942	376
Noncommissioned Officers' Course	1924	1,129
Sanitary Specialists' Course	1940	712
Officer Candidate Class	1941	2,132
Medical Inspectors' Course		51
	Total	13,097

SUMMER TRAINING CAMP	DATE CAMP FIRST HELD	NO. MEN COMPLETING TRAINING
Basic Training (June)	1925	1,620
Regimental Training (July)	1923	4,655
Hospital Commandus	1928	188
	(discontinued in 1931)	
Reserve Officers' Training Corps		6,198
	Total	12,661
	Grand Total	25,758

*As of December 1, 1942.

DEMONSTRATION TROOPS

It is obviously impossible to give practical instruction in medical field service without demonstration troops. Our wise Chinese friends tell us that one picture is worth a thousand words. It is certainly true in teaching military science and art. When the Medical Field Service School desires to show how military medical units are set up and how they function in the field, practical demonstrations are arranged. Actual aid stations, collecting stations, clearing stations, field hospitals, and the like, are set up before the eyes of the students. Students help in such demonstrations and the picture is indelibly impressed on their memories.

At Carlisle Barracks there are a series of what the soldiers call "wars"; that is, demonstrations of the work of the Medical Department in selected typical military situations. A simulated "front line" is fixed, and men taking the part of wounded are evacuated therefrom through the various stages, through the various echelons, to the rear where they are to receive treatment in the appropriate hospital. Of course, in such demonstrations the distances between units and stations is foreshortened. Otherwise the stage is set as nearly as possible like the real thing.

The First Medical Regiment, a part of the First Division, was long stationed at Carlisle Barracks and served as demonstration troops. When the reorganization of the army took place in 1940, and the large or "square"* division of the first World War was abandoned, it was necessary to change the demonstration troops at Carlisle Barracks. The First Medical Regiment was transferred to Fort Ord, California, since for a time the National Guard retained the "square" divisions. In its place at Carlisle Barracks there was created a new medical organization, the Thirty-Second Medical Battalion, some of the seasoned men of the First Medical Regiment being retained as a nucleus of the new body. The new or "triangular"* division of our present Army is much smaller than the old "square" division, and has a medical battalion instead of a medical regiment. Our new demonstration organization has taken over the splendid barracks constructed for the medical regiment and the work goes on.

The mission of the Thirty-Second Medical Battalion is thus to demonstrate to students of the Medical Field Service School the current methods of performing those military functions which are outlined in theory from the lecture and conference platform. It shows how the provisions of *Army Regulations* and the numerous *Training Manuals* should be carried out. Thus, its work differs somewhat from that of any other medical battalion, for it merely shows how to give medical support to an infantry division, but does not have actual care of patients. It could at any time take the field and perform such duties.

The Thirty-Second Medical Battalion has to be able to demonstrate the work of any medical battalion, and something more. It must also be prepared to demonstrate the work of other medical units, such as those which normally function in the front and in the rear of the medical battalion in combat. In

*The "square" division was so called because it consisted of two brigades, each including two infantry regiments with supporting artillery and service troops. A "triangular" division consists of three infantry regiments with supporting artillery and service troops. The "square" division included some 22,000 men and was in vogue in World War I. The "triangular" division of some 15,500 men is the only infantry division now found in the United States Army.

other words, its personnel must understand not only their own work, but also the work of many other instillations. To insure better discipline its men use rifles in drills, it being understood that in actual field operations rifles would not be used. Medical soldiers are unarmed, except for a small number of automatic pistols, authorized by the Geneva Convention for self-defense and for the defense of patients in their care.

Since the demonstration troops at Carlisle must be able to stage mimic battles, the men of this organization must be able to play the roles of infantry, artillery, and other troops for demonstration purposes. They are like a stage army, but a stage army that can actually do in real life the things they demonstrate on an outdoor "stage" covering many square miles. The officers, many of whom are graduates of the Command and General Staff School at Fort Leavenworth, must understand the tactics and technique of the other arms and services.

Fig. 12.—Carlisle Barracks Troops at the New York Flag Day Parade, June 14, 1942. This photograph by A. F. Sozio was taken without the knowledge of the 32nd Medical Battalion and the Medical Field Service School Band here seen passing the reviewing stand. The fine military appearance of these soldiers won them the official commendation of Lieutenant-General Hugh A. Drum, Commanding the Second Army.

The skill acquired by the personnel of the demonstration troops at Carlisle Barracks has resulted in frequent withdrawals of cadres of officers and men to form the nuclei of new organizations. They are the leaven which causes a new medicomilitary unit to develop to its desired size and skill.

EQUIPMENT LABORATORY

The Medical Department Equipment Laboratory is one of the important entities of Carlisle Barracks. Here are developed apparatus and appliances for use by the Medical Department in the field. New ambulances and other

vehicles are built and tested. New articles of equipment, such as first-aid packages and containers, field x-ray apparatus, litters, and equipment for battalion aid stations, are developed. Indeed, whenever a new problem as to medical supplies or equipment arises, it is this laboratory on which falls the duty of creating a model to fill the need. Many of the now standard articles of medical equipment were first only working models at the Medical Department Equipment Laboratory, and after passing rigid tests, were finally adopted by the War Department on the recommendation of the Surgeon General.

The variety of equipment and apparatus developed at the Medical Department Equipment Laboratory is very great. Some of the articles long in standard use in the military service had their origin in working models developed in this laboratory. Some of the more recent models include:

1. *Four-Wheel Drive Cross Country Ambulance:* With a capacity for four litter or seven sitting patients, this ambulance can operate over roads in any condition or cross country.

2. *Multiple Motor Ambulance (Bus Type)*: This vehicle operates at rapid speed over paved highways and at moderate speeds over rough roads. It has a capacity for 20 sitting patients or 12 litter patients.

3. *Animal-Drawn Cavalry Ambulance:* Even in this age of mechanization our Army still has some horse cavalry and horse-drawn artillery. Obviously, to be of service to such units, ambulances must be able to go wherever the units themselves go. This ambulance answers such requirements. Its low center of gravity makes it hard to overturn and makes it most effective on rough terrain.

4. *Mobile Surgical Hospital:* This unit is actually a hospital, contained in fourteen vehicles. There are seven large vans, of the semitrailer or bus type, four of which are complete operating rooms, the fifth a sterilization room, the sixth an x-ray room, and a supply room and office. There are also two power trucks for supplying electric current, two cargo trucks, one of which is a kitchen; one Engineer Purification Unit truck, and two command cars.

5. *Mobile Army Medical Laboratory:* One large motor van is thoroughly equipped for laboratory work in the field.

6. *Hospital Trains:* This includes a twenty-ton box car, for use in the combat area. The hospital train includes 16 ward cars, two cars for Medical Department enlisted men, one car for officers and noncommissioned officers, one dressing and dispensary car which includes the kitchen, and one utility car. Besides these the number of ward cars varies according to the immediate needs, depending on the number of casualties. A hospital train unit car, built by the Pullman Company in accordance with the specifications of the Medical Department Equipment Laboratory, was sent to Carlisle Barracks for study. It is designed to furnish food and operating room facilities for a full trainload of patients in the Zone of the Interior. Attached would be a baggage car and a variable number of sleeping or chair cars.

7. *Arctic Medical Unit:* Full equipment is carried in a pack by the medical soldier on skis. In transporting the wounded the skis and litter form a sled for the patient while the medical soldier uses snow shoes.

Among the other pieces of equipment more recently developed are a portable field disinfector, wheeled litter carrier, pack carriers for equipment of medical detachments, folding arm splint, folding leg splint, flight service chest for use by medical units with the Air Forces, field operating light with generator, new individual equipment for the medical soldier and for the medical officer, a new first-aid packet, a portable still, chemical heat pads, neon emergency operating lights, and new medical equipment for parachute infantry. A recent development is the medical equipment for use with parachute troops, material that can withstand parachute dropping.

The foregoing articles of equipment were displayed by the officer in charge of the Medical Department Equipment Laboratory and his staff at the meeting of the American Medical Association in Atlantic City, June 6-12, 1942. The greatest interest was manifested by delegates and other visitors.

Medical Field Service School's First War Casualty.—On March 26, 1942, Major James Augustus McCloskey (1909-1942), Medical Corps, a graduate of the Medical Field Service School in 1937, was killed in action in the Bataan Peninsula, Philippine Islands. He is our first war casualty, though there have been others reported since. A tablet in his memory has been placed in the Chapel of the Medical Field Service School, dedicated with appropriate ceremonies.

Medical Administrative Officer Candidate School at Camp Barkley, Texas.—So great has been the need for officers for the Medical Administrative Corps that on April 15, 1942, the War Department ordered the creation of a second school for the training of approved candidates. It was established at Camp Barkeley, Texas, and was organized so rapidly that the first class began its instruction on May 9, 1942, and has since been graduated. This school is doing work comparable with that carried on at Carlisle Barracks, though, of course, with less equipment. No instruction of officers is given at Camp Barkeley.

While the Officer Candidate School at Camp Barkeley is not a branch of the Medical Field Service School, it is, in effect, an offspring of it. The Commanding General of the Medical Replacement Center at Camp Barkeley, Brigadier-General Roy Cleveland Heflebower, is a medical officer, and the Assistant Commandant and other members of the faculty of the Camp Barkeley School were taken from the faculty of the Medical Field Service School. The curriculum at Camp Barkeley is essentially the same as that of Carlisle Barracks. The medical soldiers at Camp Barkeley furnish ample demonstration units in connection with the training of the officer candidates.

Since the preparation of this report, the War Department has ordered that effective January 1, 1943, the Officer Candidate Classes at the Medical Field Service School be discontinued upon graduation. Thus by March 1, 1943, there will be no more student candidates under instruction. In future the training of candidates for commissions in the Medical Administrative Corps will be carried out at the Medical Replacement Center at Camp Barkeley, Texas. Thus the whole effort of the Medical Field Service School will be devoted to the training of officers. The course will be extended to six weeks instead of one month as at present. The special courses for officers will also be given at Carlisle Barracks as needed.

CONCLUSION

The medical profession of our country owes much to the Army Medical Department. Some of the greatest advances of American science have been made by our medical officers. Many of them are not well known as Army gifts. Army medical officers have *inter alia* given our country its first medical book, its first pharmacopoeia, its first textbook on bacteriology, its greatest bibliographical work—the Index Catalogue of the Army Medical Library. Army medical officers introduced vaccination to America, developed our present system of typhoid fever prophylaxis, showed that the mosquito transmits yellow fever, created America's first school of preventive medicine, developed the largest medical library the world has ever known, established the largest medical museum in America, first showed the importance of proper ventilation, created the first large American hospital (the New York Hospital), introduced photomicrography, invented the purification of drinking water by liquid chlorine, and many another piece of scientific research and achievement which now benefit mankind. They have successfully fought epidemics of many kinds and in many quarters of the globe.

The school developed by the Army Medical Department at Carlisle Barracks is, we believe, proving itself one of the Army's worth-while gifts to the whole country. It is worthy of inclusion in the above roll. If by its teachings it can prepare medical officers more efficiently to care for soldiers in the field, to prevent disease and injuries wherever possible, and to cure them when they have been unavoidable, it will have accomplished a noble mission. When such mission is one that intimately concerns every household in the land, it is of supreme importance indeed. To the end that our men may be the better protected, the Medical Field Service School devotes its every energy and its every thought. Its personnel are mindful of the full purpose of the school's motto: "To Conserve Fighting Strength." These words are not merely worn on the badge of the school that forms a part of its personnel's uniform. They are deep set into the conscience of every man connected with this seat of learning on which so much now depends.

Fig. 13.—Coat of arms of the Medical Field Service School.

THE MANAGEMENT OF THORACIC WAR INJURIES*

JAMES H. FORSEE, M.D., LAWRENCE M. SHEFTS, M.D., BENJAMIN BURBANK, M.D., LEO J. FITZPATRICK, M.D., AND THOMAS H. BURFORD, M.D., U. S. ARMY

THE management of thoracic injuries has always constituted a serious and significant problem. The frequency of chest injuries and the attendant high mortality demand more than passing attention. Berry,[4] in quoting Hoche's review of 11,000,000 wounded in World War I, stated that thoracic wounds were third in order of frequency and the mortality of this group was 56 per cent, whereas the total mortality was only 8 per cent. Further, in reviewing the cause of death among 12,350 killed, Hoche found that thoracic injuries accounted for 20 per cent and was second only to head injuries. DeBakey,[14] in his excellent collective review, quotes Sauerbruch, Crafoord, Trueta, and Loeffler as finding the frequency to be from 12 to 40 per cent. Such frequency and mortality justify a serious and detailed consideration.

That a considerable proportion of deaths occur near the scene of the trauma is evidenced by Duval's statistics, as quoted by DeBakey.[14] He found that the mortality decreased progressively from advanced aid stations to base hospitals, being 30 per cent at aid stations and 15 per cent in base hospitals. The one factor which can and will reduce such fatalities is the earlier definitive treatment by surgeons trained in the management of thoracic injuries. To effect this it is necessary, in the mobile war now occurring, to have an equally mobile system of evacuation and treatment, flexible enough to meet casualties soon after the injuries are incurred. This entails first, the special training of surgeons and their assistants in the care of chest wounds, and second, an organization whereby they are available on short notice to function in properly equipped medical installations at the point of maximum casualties close to the battle front.

The success of such an attempt in reduction of mortality depends largely on the ability of the personnel and the proper functioning of the medical installations in which they work. Surgeons especially trained in thoracic surgery not only must be used in carrying out the necessary surgery but also as instructors in training general surgeons in the immediate care of thoracic injuries. There are too few specialists in thoracic surgery of field age available. This deficiency can be remedied by the training of general surgeons in the fundamentals of thoracic physiology. This training could best be carried out in hospitals where chest cases would be concentrated. Such centers would also permit training in bronchoscopy and would make possible the training of anesthetists in the technique of endotracheal anesthesia. We feel that as the advent of endotracheal positive pressure anesthesia has been a very important factor in the great advances of thoracic surgery in the last decade, it can be an equally important

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factor in the decrease of mortality in war wounds of the chest. Such a program would fulfill the necessity for early definitive treatment by trained personnel.

The second factor involved is one of time and distance. Reduction of the interval of time between injury and definitive treatment resolves itself into either having the surgeon immediately available to the fast changing mile-devouring fronts or having rapid evacuation of the wounded by airplane or motor to the surgeon.

A program of early definitive treatment by trained personnel as outlined above will not only reduce mortality of thoracic injuries but also decrease morbidity, reduce the number of days of hospitalization, and eliminate a large number of chronic empyema cases which linger on long after the war is over and which are the obvious result of treatment usually applied late and incorrectly. The elimination of such a large group, requiring hospital care for many years, would be economically sound.

The more important problems concerned in a presentation of the management of thoracic injuries include a discussion of the relation of wounds to types of projectile, shock, hemorrhage, open pneumothorax, tension pneumothorax, interstitial pulmonary emphysema, massive collapse of the lung and contrecoup injury, "blast lung," ecchymotic mask, cardiac concussion, wounds of the heart and pericardium, cardiac resuscitation, acute and chronic empyema, foreign bodies, combined abdominothoracic wounds, chemotherapy, and anesthesia in thoracic injuries.

RELATION OF TYPE OF PROJECTILE TO WOUND

The steel-jacketed small caliber bullet, as used in small arms fire, will result in a perforating wound. Although the path of the bullet from point of entrance to point of exit may be very bizarre, ricocheting far from its original line of entry, the wound caused is not of the type produced by high explosive. Its long and narrow path is marked by a coagulated and seared trail. However, in injuries from shrapnel, high explosive artillery shells, hand grenades, bombs, or debris of falling buildings, large lacerated wounds of the chest result with serious prognosis.

In receiving casualties from a given sector, the knowledge of the type of small arms used and the type of high-explosive shells laid down by the artillery can usually be ascertained; this knowledge is important in planning the care of casualties already present as well as preparing for the expected additional wounded.

SHOCK

When a patient is first seen with a chest injury, it is often difficult to determine whether the shock present is due to hemorrhage or to a disturbance in the cardiorespiratory mechanism. In such cases any obvious source of hemorrhage must be immediately controlled, and heat and oxygen therapy must be promptly administered. Such conditions as sucking wounds of the thorax or rapidly progressing tension pneumothorax will produce the symptoms of marked shock. Numerous fractured ribs approaching the "stove-in chest" or "hinge fracture" with its many anterior and posterior fractured ribs should be immediately immobilized. The correction of the abnormal mobility of such a chest will

rapidly decrease the intensity of the shock. The simplest and often the most efficient immobilization is the circumferential strapping of the lower costal margin, as advocated by Blades.[6] A rapidly decreasing vital capacity as the result of pulmonary collapse from bleeding into the pleural cavity can simulate the complete clinical picture of shock. The reduced vital capacity has as a result a proportionate anoxia. The resultant shock is generally not due solely to blood loss into the pleural cavity but to the sudden decrease of vital capacity associated with mediastinal shift. In such instances the patient should be placed in a semisitting position, since he is usually more comfortable and can breathe more easily in this position. The same position should be used following treatment for any condition wherein the vital capacity has been decreased. Vital capacity is often further decreased by reduced respiratory excursion resulting from pleural pain, the most common cause of which is fracture of the ribs.

The treatment of shock in chest injuries requires the same close attention as it does in other injuries producing shock. Plasma transfusions are especially valuable in correcting hemoconcentration wherein actual blood loss has not been marked. In chest injuries, however, immediate attention must be given to correcting the abnormal thoracic physiology. A sucking wound of the thorax must be closed, a tension pneumothorax must be relieved, and hemorrhage from intercostal or internal mammary vessels must be controlled. Morphine is indispensable for the relief of pain in combating or preventing shock. It is also important to remember that considerable loss of body heat occurs in open wounds of the chest and immediate closure is the only effective control.

HEMORRHAGE

Hemorrhage in thoracic injuries not involving the heart is from one of three sources; chest wall, parenchyma of the lung, or from the large vessels at the hilus of lung. A hemothorax may occasionally occur from contusion of the chest.

Severe hemorrhage from the chest wall arises from either the intercostal or the internal mammary vessels. When circumstances do not permit a careful exposure of a bleeding intercostal vessel, two circumcostal sutures including the rib, placed above and below the bleeding point, may suffice. In this connection the anatomic position of the intercostal vessel should be recalled. The intercostal artery medial to the angle of the rib is approximately in the center of the intercostal space, and from that point anteriorly the vessel progressively approaches the inferior border of the rib above so that from the angle of the rib forward the vessel is under the edge of the rib in the subcostal groove and simple circumcostal massive suture may be insufficient. In hemorrhage from the internal mammary artery it is imperative to ligate both ends of the lacerated vessel since hemorrhage can occur from either end. The vessel is located approximately one-half inch lateral to the edge of the sternum. Exsanguination may occur in a few hours from unchecked hemorrhage from the internal mammary artery. Hemothorax in which there is no lesion of the chest wall or parenchyma of the lung may occasionally be caused by contusion of the chest.

Hemorrhage due to injuries of the parenchyma of the lung will often be associated with a pneumothorax and a hemopneumothorax will result. In the absence of fractured ribs or wounds in the region of the intercostal or internal

mammary vessels it may be assumed that the etiology of a hemopneumothorax is parenchymal bleeding. Hemoptysis may or may not occur. The immediate effect of parenchymal bleeding into the pleural cavity will be a compression of the lung and the compression often stops the bleeding. The after treatment of hemothorax once the hemorrhage has stopped resolves itself into any method that will re-expand the collapsed lung. There are in the main three schools of thought: first, energetic aspiration repeated often enough to keep the chest dry; second, watchful waiting in which aspirations are performed only to relieve cardiorespiration embarrassment; third, a line of treatment that is somewhat midway between the two. This consists of aspirations (not primarily aimed at keeping the chest dry) and of partial replacement with air. The first has the advantage of removing an excellent culture media, but it has the disadvantage of possibly reviving the hemorrhage due to the high negative pressure resulting from removal of a large amount of blood without replacement with air. The second is advantageous only in that less exertion is necessary in treatment. It has the definite disadvantage of a long period of hospitalization awaiting absorption of blood and re-expansion of the lung with the probability of a resultant fibrothorax, and prolonged chronicity. Further, should infection develop it would occur in a large pleural space and a total empyema often results. The third method is repeated (after seventy-two hours) with partial replacement by air. The aspirations are so spaced as to empty the pleural cavity of blood gradually. The air replacement should be controlled by noting the intrapleural (pressure) readings as recorded on a pneumothorax apparatus. If such an apparatus is not available, air may be replaced in a proportion of 50 per cent of the fluid removed. This was popularized by Morelli[39] in World War I.

Severe lacerations of the parenchyma, especially those extending into the hilus and involving the large vessels, may necessitate lobectomy or even total pneumonectomy. These will most often be associated with large open wounds of the chest and will be available to actual inspection. If adequate facilities are available and the condition of the patient permits, individual ligation lobectomy, as described by Blades and Kent[7] should be done. If hemorrhage is massive and the condition of the patient does not permit a lengthy operation, then massive tourniquet ligation is indicated. It seems probable that lobectomy will be employed with greater frequency in the early management of severe pulmonary injuries, and if properly employed, will, it is believed, be highly successful.

OPEN PNEUMOTHORAX

Trauma to the chest resulting in open wounds exposing the lungs is not always fatal. The same may be said of bilateral open wounds. Graham[18] and Bell proved experimentally that a wound exposing the pleural cavity could be tolerated if the amount of air entering the wound was not greater than the difference between the tidal air and original vital capacity. Thus the important factors are the size of the wound and the original vital capacity. The lung on the injured side does not collapse to a point wherein it is nonfunctioning when it is exposed to atmospheric pressures even when the pleural cavity is free of adhesions. During the respiratory cycle the pressures exerted on the exposed lung are not always atmospheric. The thorax is a flexible moving container during

the respiratory cycle, and there may be even negative pressures in the exposed side during inspiration.[18] This permits a rush of air through the glottis in answer to the negative intrapulmonic pressure occasioned by the enlargement of the chest on inspiration. Thus, if difference of pressures permit of the entrance into trachea of amounts of air to answer the tidal air requirement, the patient will not die of asphyxia. There is also the factor of interference with function of the contralateral side. In the healthy person the mediastinum which is free of adhesions and is not stiffened by previous inflammatory involvement permits transmission of pressures through it so that almost identical pressures may be found in both pleural cavities. Thus the decrease in vital capacity from an open wound of one side of the chest arises from both lungs. This has the practical effect of a tolerance of larger wounds in persons with a stiffened mediastinum.

If the amount of air entering the open chest wound during each inspiration is large enough to interfere with intake of the tidal air requirement, asphyxia will occur. In such cases an interesting and vicious chain of events ensues immediately. There is an initial decrease in vital capacity. The exposed lung will move to the degree that the mediastinum shifts with each unopposed inspiration and expiration of the contralateral lung. This resultant mediastinal shifting increases in rapidity as anoxia from the initial reduction in vital capacity becomes more marked. This shifting is termed "mediastinal flutter." Such shifting will have a direct effect on the right side of the heart. Since the base of the heart is fixed as compared to the apex, it will permit considerable movement of the apex. This shifting on the base follows the rapid fluttering of the mediastinum, and kinking of the large vessels entering the right side of the heart will ensue. Anoxia further is increased by the phenomena of pendulum respiration. On each expiration the air from the contralateral lung with its predominant carbon dioxide content is only partially exhaled, and part goes over into the main and secondary bronchi of the collapsed side. On the next inspiration the air taken into the contralateral lung is composed of atmospheric air from the trachea and air with a high carbon dioxide content of the air reaching the contralateral lung. Thus the chain of events starts with a reduction in vital capacity which involves both lungs, and each step further decreases it. The shifting mediastinum interferes with the proper filling of the right side of the heart, the progressive anoxia of pendulum respiration ensues and must be treated as an extreme emergency. To break the chain of events closing the wound of the chest is the method of attack.

The immediate treatment of open wounds of the thorax is simplicity itself. Closure of the wound is imperative. This can be done by gauze pads and adhesive applied so as to make an airtight dressing. As soon as possible it is essential that the wound be closed surgically, for it is seldom that a dressing of such a wound remains airtight for very long. If adhesive and gauze is not available, large safety pins may be used to close the wound. At the time of the dressing any obvious foreign bodies should be removed from the pleural cavity, and all foreign bodies should be removed when the wound is later closed surgically.

The essential point is that the open pneumothorax must be converted into a closed pneumothorax. The test of the efficiency of the emergency closure is the absence of the sucking noise accompanying respiration.

If the parenchyma of the lung is lacerated, closure of the wound of the chest will convert the open pneumothorax into a progressive tension pneumothorax. This then poses a problem in field conditions, for once the wound has been closed it is necessary to provide an outlet from the pleural cavity which is equal to, or greater than, the opening of the lung into the pleural cavity. This outlet must be a one-way valve, permitting the escape of air from the pleural cavity to the outside. This is accomplished by closure of the wound and installation of a catheter into the pleural cavity and connection of the catheter to a water-seal bottle. The water-seal bottle should always be kept below the level of the chest. No complicated apparatus is necessary, for under local anesthesia through a skin incision the catheter may be introduced into the pleural cavity through an intercostal space. If the patient is to be transported a considerable distance, the water-seal bottle may be too cumbersome and a rubber flutter valve may be substituted. Such a flutter valve may be made by slitting the finger of a rubber glove so that a flap is produced. If it is feasible to close the wound surgically shortly after it occurs, and if the lung is lacerated to a degree that simple suture is insufficient and the patient's condition precludes lobectomy, the lacerated portion of the lung may be sutured into the wound. This may tide a patient over a critical period and more definitive surgery may be done later under more favorable circumstances.

It will bear repetition that treatment of the accompanying shock, position of patient, oxygen, warmth, plasma transfusion, and sedation is essential.

TENSION PNEUMOTHORAX

Tension or pressure pneumothorax is the result of a pleuropulmonary connection.* This connection is the result of rupture of the parenchyma, and the tear acts as a one-way valve which permits the entrance of air from the parenchyma into the pleural cavity. There is no opening for the air to escape through an intact chest wall and the pressure in the pleural cavity will rise progressively. The rapidly progressing tension pneumothorax causes marked dyspnea and all accessory muscles of respiration are utilized. Cyanosis becomes prominent as the mediastinal shift causes interference with heart action and the veins of the neck become prominent. Dyspnea and further reduction in vital capacity result from mediastinal displacement. The displacement is away from the involved side. The patient sits in a semierect position, and as the dyspnea increases, the patient's worried anxious expression is as expected of one fighting for his breath. It is essential to decompress the pleural space immediately. Whether it is necessary to maintain continuous decompression depends on the size of the pleuropulmonary opening. Repeated decompression by needle aspiration may suffice, but if aspirations have to be repeated for more than once daily, it is probably far safer to install a continuous decompression. In injuries occurring on the battlefield the average case has a greater margin of safety by this method. This may be done by introducing a large bore, Nos. 14 to 16 gauge

*A tension pneumothorax may also result from a pleurocutaneous wound.

needle, into the pleural cavity, strapping it in place, being careful not to obstruct the lumen of the needle. If such needles are not large enough to accomplish decompression, an intercostal catheter connected with an under water-seal bottle must be used. Besides the patient's obvious dyspnea and cyanosis, a constant check on the efficiency of the decompression is the position of the trachea as palpated in the neck. As decompression is accomplished, the trachea resumes its midline position from its displacement away from the side of the tension pneumothorax.

INTERSTITIAL PULMONARY EMPHYSEMA

Spasm of the glottis is a reflex mechanism of sudden compression injury to the chest. As a result, air is trapped in the lungs and compression of the chest raises the intrapulmonic pressure suddenly, and rupture of alveoli in the parenchyma of the lung occurs. The pumping action of respiration forces air out into the interstices of the parenchyma. The air travels along the branches of the bronchi and blood vessels, ascending to the hilus and thence up the mediastinum.[14] The appearance of subcutaneous emphysemas at the base of the neck may be the first indication that such a condition exists. Roentgenograms will reveal presence of air in the mediastinum. This condition may be found in absence of any pneumothorax, fractured rib, or hemothorax. This condition has been noted in patients suffering from severe asthmatic attacks.

Treatment consists of watchful waiting. In most instances spontaneous recovery results. It is essential to note whether or not there is extension of the emphysema from the base of the neck outward to the shoulders, up into the neck, and down onto the chest. If this extension is present, then it is evident that this is acting as a decompression, thereby relieving the pressure in the mediastinum. If the air does not disperse itself as described above, the pressure will rise in the mediastinum and tend to compress the large veins. This will interfere with filling of the right side of the heart and obvious distention of the neck veins will occur. Simply marking on the skin each day the progress of the emphysema is a sufficient guide. If the neck veins become distended, and there is no increase in subcutaneous emphysema, then a mediastinotomy is in order. Mediastinotomy carried out just medial to the lower end of the sternomastoid muscle entering into the superior mediastinum will usually suffice.

MASSIVE PULMONARY COLLAPSE AND CONTRECOUP INJURY

Massive pulmonary collapse occurring as a result of trauma to the chest may involve all the lobes of one lung, but more often it involves one, or at most two, lobes. This condition may also result from trauma to the abdomen. In either trauma to the abdomen or chest the actual amount of trauma may be relatively insignificant. Collapse may occur from pressure effects of bomb or shell explosives. In cases of direct trauma or pressure effects of explosions, a contrecoup collapse may occur with only minor involvement of the homolateral side. The mechanism of massive pulmonary collapse is obscure. One theory is that it is a reflex inhibition of movement of the chest wall with interference of the usual aeration.[47]

Clinically, the patient will present far more dyspnea than one would expect from collapse of one lobe. Cyanosis even though more than expected is not as

marked as the dyspnea. The trachea is found deviated to the side of the collapse. Cardiac dislocation toward the affected side will usually be found. Sudden rise in temperature from normal to 103° or 104° F. is also a common finding. Physical findings of a nonaerating lobe or lobes will be found. Following spontaneous aeration or in aeration following treatment, râles will appear, and in spite of roentgenologic evidence of good aeration and disappearance of the dyspnea and cyanosis the râles may remain for several days.

Treatment is directed toward reexpansion of the involved lobes. Use of carbon dioxide is recommended to increase the depth of respiration. The patient should be turned with the involved side up and made to cough at five- to ten-minute intervals. If coughing is weak and ineffectual, intubation may be carried out without moving the patient from the bed. A curved semirigid rubber catheter (McGill) may be inserted directly into the trachea, and sudden suction of considerable intensity should be applied to the catheter. During the intubation the patient will often cough strenously enough to aerate the lobes involved. If these measures fail, then bronchoscopy should be carried out to remove mucus from all bronchial orifices. Such endoscopy should be done under local anesthesia and without anesthetizing the vocal cords or trachea. In a surprisingly large number of cases the collapse will disappear following bronchoscopy wherein only small amounts of mucus are aspirated from orifices of bronchi to the involved lobes. It is imperative that treatment be immediate and energetic. Permitting such a collapse to persist will, in the majority of cases, result in pneumonic consolidation. If there is any question of the persistency of the collapse, prompt use of sulfonamide drugs will often prevent an otherwise serious pneumonia. It is felt that the majority of postoperative pneumonias are preceded by some degree of similar collapse.

BOMB BLAST ("BLAST LUNG")

Mass bombing with high explosives has accentuated the importance of blast injury to the lung. Zuckerman and his coworkers,[53] through an extensive series of experiments, have shown that the injury is due to the direct impact of the wave upon the chest wall. Lesions have occurred even when the suction component was excluded.

Experimental animals subjected to the detonation of high explosives show the following sequence of events: There is an initial fall in blood pressure which is ascribed to shock from trauma. Those animals who survive this initial shock, but develop pulmonary lesions, reveal a lowered blood pressure and marked dyspnea. These effects are due to the parenchymal changes, which result from the sudden compression of the chest wall by the wave of high pressure, which simultaneously retards expulsion of the air through the trachea. As a result, the delicate alveolar tissues are ruptured. At the same time the reserve of the pulmonary capillary bed is reduced.[37] Wearn has shown that reduction of this, especially when accompanied by an increase in the blood volume, results in an increase of the intrapulmonary pressure and subsequent fall in the systemic pressure. If the available capillary reserve is reduced to the point where it is insufficient for even the resting venous return, pulmonary edema will result.

Pathologically, the most persistent finding in these animals was multiple areas of hemorrhage in the parenchyma of the lung.[54] These hemorrhagic areas

are most common along the line of ribs, suggesting that these have been driven forcibly against the lungs with resultant contusion. Microscopically, the typical lesions consisted of rupture of the alveolar wall, with hemorrhages originating from the torn alveolar capillaries. The alveoli and smallest bronchioles were filled with blood. Where hemorrhage was severe, frequently there was collapse of the corresponding lobe.

The findings in clinical cases of blast injury are very similar in all respects to those of the experimental animals. Many patients who died had no evidence of external injury and just showed blood-stained froth in the mouth and nose. Post-mortem examination revealed the pulmonary hemorrhages and torn alveolar structures. In patients who have survived the initial blast, there is evidence to indicate that there occurs a diapedesis of red blood cells from intact capillaries which is progressive and lasts for as long as fifty-one hours.[23, 24] Those patients who survived presented the following clinical features: Shock was evident in all and profound in many. Dyspnea was universal, but in many cases did not become very evident until forty-eight to seventy-two hours following the injury.[13] Cyanosis was present in all cases and was proportionate to the degree of injury. Chest pain was of two types, a constant, deep central type and lateral pain which was associated with the respiratory movements.[42] Abdominal pain and rigidity was the predominant finding in some cases, but each case subjected to laparotomy failed to disclose serious intra-abdominal injury. Hemoptysis was not frequent, but blood-stained sputum was common. Cough and expectoration were absent in the first twenty-four hours but invariably appeared thereafter. Rupture of the eardrums was practically pathognomonic.

Physical signs were very meager. A universal finding was the "ballooning of the lower part of the chest."[42] The thorax was apparently one-half to three-fourths distended and fixed in the position of inspiration. Percussion resonance was usually normal. Breath sounds tended to be distant and râles were variable. X-ray examination was of great help in establishing the diagnosis. The typical picture consists of bilateral mottling of the lung fields, resembling a patchy bronchopneumonia, which usually clears in seven to ten days.[42]

It should be noted that in bombing casualties, not all persons in whom there is no external evidence of injury die from the direct effects of blast. Indeed, the English observers emphasized that more people die from such indirect effects as asphyxia, carbon monoxide poisoning, injuries sustained from being trapped in collapsing buildings, and injuries from missiles. The diagnosis of true blast injury of the lung rests upon a reliable history, the presence of shock in the absence of any external injuries, and the development of serious respiratory difficulty.

Treatment of this condition is based upon the foregoing observations. Absolute rest is imperative and should be continued until x-ray examination reveals complete clearing of the lung fields. Oxygen is essential in most cases. In the presence of venous congestion and pulmonary edema, venesection may be a life-saving procedure. Abdominal laparotomy should not be undertaken unless positive proof of intra-abdominal injury is obtained. Any operative procedure should be delayed as long as possible. Transfusions and intravenous fluids are definitely contraindicated. Zuckerman has shown that chests which are well

padded are protected from blast injuries.[54] This obviously proves the necessity for air raid shelters. In the absence of such protection one should assume the prone position, especially behind some substantial structure.

ECCHYMOTIC MASK

A unique condition is "ecchymotic mask," a bluish-violet discoloration of the upper portion of the face and neck extending downward to include the upper portion of the chest which results from sudden direct compression of the chest or abdomen. An excellent consideration of this subject has been written by Heuer.[27] In civilian life it has most often been seen following compression of the chest between the rear end of a truck and a loading platform. Sudden direct compression of the extremities while the patient falls, or is thrown with thighs flexed on the abdomen directly, transmitting the compression to the abdomen, may also give rise to this condition. In wartime such compression may occur from falling debris in bombing with the patient actually crushed. The discoloration is usually more intense at the areas of pressure, such as collar bands, hatbands, and suspenders.

The mechanism is that of marked venous stasis in dilated but intact peripheral venous capillaries. There is no evidence of diapedesis. The intact vessels and absence of extravasation found microscopically, and the absence of usual shades of color occurring as an ordinary ecchymotic spot fades is proof of the stasis in intact vessels. The discoloration may also be found in the pharyngeal and buccal mucosa. In these regions, as well as in the conjunctiva and retrobulbar regions, actual hemorrhage may occur.

Clinically, the discoloration starts to fade at about the second day and usually disappears in two weeks. As a rule, patients are not uncomfortable and the majority clear up without sequelae. There may, however, be ocular symptoms, ranging from mild blurred vision to complete blindness. The retrobulbar hemorrhage, or fundal hemorrhage, may result in permanent optic nerve atrophy. Fortunately, ocular involvement occurs only infrequently.

CARDIAC CONCUSSION

Bright and Beck[10] and Warburg[52] have presented excellent reviews of this subject and have come to the following conclusions: Trauma to the intact chest may be indirectly transmitted to the heart. This is especially true in the young adult, for the chest is far more resilient and flexible than in an older person, permitting the striking force to be more damaging to the heart. The type of injury may be a direct blow over the precordial region, anteroposterior compression of chest between two solid objects (as described in section on ecchymotic mask) or a blow to the abdomen causing sudden rise in intra-abdominal pressure. As can be seen from the above types of injuries, one must be on the lookout for cardiac involvement in any compression injury.

Sufficient experimental work has been done to explain the pathologic physiology. Trauma may cause an actual immediate rupture, and death ensues promptly. The majority of cardiac injuries reported which resulted in death consisted of immediate rupture of one of the chambers. Actual contusion may occur, with hemorrhage and softening and eventual cardiac rupture. The contusion with resultant petechial hemorrhages may commonly involve any portion

of the conduction system. However, the most frequent injury is that causing a reflex spasm of the coronary vessels with a syndrome not unlike that of the common coronary occlusion seen in civilian life causing infarction. Immediate hemorrhage near a coronary vessel or conduction system may interfere with the lumen of the vessel or the functioning of the conduction system, respectively.

It has also been proved experimentally that in case of vagosympathetic imbalance or in a heart sensitized by adrenalin cardiac irregularities may not only occur but coronary spasm may more readily result. Therefore, in the heat of battle with the vascular system surcharged with considerable adrenalin slight trauma to the chest may cause considerable cardiac disturbances.

Clinically, the patient may be dazed or unconscious. If there is no immediate rupture, the patient may rapidly recover and have no subjective symptoms for a period of from several hours to several days, at which time precordial pain or discomfort may develop as a result of vascular occlusion, or the usual dyspnea and choking sensation of cardiac irregularities may ensue.

Clinically, a wide variety of syndromes may be expected. In cases of delayed cardiac rupture from actual contusion there may be a period of one to two weeks from time of injury to sudden development of a cardiac tamponade. In instances of hemorrhage in, or adjacent to, the conduction system a number of cardiac irregularities may result. Ectopic contractions, auricular fibrillation, and auricular flutter may occur. Various types of heart block have been reported. The latter have been found in absence of any marked demonstrable cardiac damage.

The basis of treatment in this type of injury is the recognition of the latent interval between injury and actual infarction and between injury and cardiac rupture from contusion. In all cases of injury to the chest as described above a regime of rest and sedation should be carried out and continued as in cases of coronary occlusion. Absolute and complete rest must be continued for a minimum of at least three weeks. In those cases of chest injury wherein cardiac irregularities are detected then a suspicion of cardiac injury becomes a certainty, and complete and continued rest is essential. Surgical intervention in case of rupture after the latent period is not as successful as in cases of penetrating injuries to the heart, because in cases of rupture due to vascular occlusion the area involved is much larger and adjacent muscle is usually very friable.

PENETRATING WOUNDS OF THE HEART AND PERICARDIUM

Penetrating wounds of the heart occur relatively rarely in civilian practice. This statement is based on Bigger's[5] report of such cases constituting only 0.1 per cent of the surgical cases at the Medical College of Virginia Hospital and Boland's[8] report of 1.4 per cent of 1.187 cases of penetrating wounds of the chest. These statistics represent only those patients who live to reach a hospital and do not represent the true total number of cases. Many probably die promptly from an extremely rapid tamponade because the wound of the myocardium is so placed as to cause massive bleeding.

In instances of bayonet wounds or wounds caused by small caliber bullets, the hemorrhage into the pericardium may be such that the cardiac tamponade will occur slowly enough to permit surgical closure. Cardiac tamponade presents

a syndrome of a progressive dropping of systolic pressure, rising venous pressure with distended neck vein, quiet distant heart tones, and increase in area of cardiac dullness. Repeated aspirations of the pericardium may be done to tide a patient over until surgical closure is accomplished. Aspiration of the pericardial cavity may be accomplished by inserting a needle in the angle between the xyphoid process and the adjacent left costal arch. The needle is directed cephalad inward and toward the left at approximately an angle of 45 degrees. Surgical repair may be accomplished through a curved incision exposing the third, fourth, and fifth costal cartilages, resection of sufficient portions to expose the pericardium, opening of the pericardium, and suture of the wound of the heart. It is essential to use positive pressure anesthesia. Technique of such closure has been fully described by Elkin[15] and Beck.[1]

CARDIAC RESUSCITATION

The problem of cardiac standstill, formerly assumed to be a problem handled only by the surgeon in a meticulously fitted operating room, is now because of war casualties a problem of all physicians wherever and whenever it occurs. Cardiac cessation results either from failure of the sinus node or as an end result of ventricular fibrillation. By far, the former is the most common cause. The idea of reviving the human heart, when its action is stopped, is feasible, as shown by Koontz,[36] who by perfusion experiments revived 65 of 127 hearts, whose action had stopped for a period of two hours. Forty-eight of these 65 (73.8 per cent) developed a regular heartbeat.

An outline for resuscitation is suggested as follows:

I. Essential factors in treatment of all cases
  A. Unobstructed airway
  B. Artificial respiration
    1. Manual
    2. Mouth-to-mouth insufflation
    3. Mechanical respirators

II. With intact abdomen and chest
  A. Blow to precordium
  B. Direct stimulation of heart
    1. Needle in right auricle
    2. Injection of epinephrine
    3. Electrical stimulation via the needle
  C. Massage of heart
    1. Through emergency laparotomy, massage conducted through an intact diaphragm
      (a) Massage through an opening of the diaphragm

III. During thoracotomy
  A. Massage of the heart
  B. Use of electrical stimulation or drugs, as indicated by topical application

IV. During laparotomy
  A. As under II. C

In any treatment of cardiac resuscitation the maintenance of proper oxygenation is imperative. Irreversible cerebral damage can occur within five to eight minutes in the presence of anoxemia. Proper oxygenation can be achieved and maintained only by assuring the immediate institution of an unobstructed airway and artificial respiration.

The problem of an unobstructed airway is essential to proper oxygen exchange. Removal of foreign body obstruction in the upper respiratory tract with the jaw held up and forward will usually suffice. The unconscious patient will not often present a spasm of the glottis, but if this does occur intubation is essential.

Artificial respiration should be started immediately. This may be accomplished by the Schaefer prone method, mechanical respirators, or even mouth-to-mouth insufflation. The important fact is that one should not await the assembling of an armamentarium sufficient to cope with the condition before starting artificial respiration. The mechanical expansion and collapse of the lungs directly helps to stimulate the heart. This has been clearly demonstrated by Thompson, Birnbaum, and Shiner[49, 50] by the phenomena of "asphyxial resuscitation." The mechanical respirators, utilizing a positive and negative pressure, are excellent when available, and if intubation is necessary, complete control of respiration is assured.

In cases of cardiac standstill occurring with an intact abdomen and chest, as soon as an obstructed airway and artificial respiration are obtained, sharp blows to precordium may induce cardiac contraction (Cordelli[12]). This is, of course, unreliable, but may be done quickly while other measures are being started. Immediate stimulation of the right auricle by a needle is next in order. Mere mechanical stimulation of the right auricle may induce contraction. It is important that the irritation occurs in the auricle. Hyman[29, 30] has shown that the "action current of injury" may produce flutter followed by fibrillation. As fibrillation of the ventricles is conceded incompatible with life, it is, therefore, necessary that the needle be inserted in the region of the right auricle. A needle about 4 or 5 inches long inserted in the third or fourth intercostal space at the edge of the sternum, directed inward and slightly caudad, will approach the approximately correct position. If mechanical irrigation does not succeed, then injection of 1 c.c. of 1:1,000 epinephrine into the right auricle is next in order. The institution of all the above can be accomplished in from eighty to one hundred and twenty seconds. Next, electrical stimulation utilizing principles as elucidated by Hyman[31] and Beck[2] may be conducted per needle. Application of electrodes directly to the heart are, of course, far more efficient. Use of ordinary electric light current, with a resistance coil to decrease the amperage to one or one and one-half amperes, may be used.

If all these measures fail, at the end of eight minutes, then massage of the heart should be instituted. Opening of the abdomen through an incision in the epigastrium large enough to admit a hand should be accomplished promptly. The patient is to all intents and purposes dead and will most assuredly remain so unless cardiac action is started. Massage is then done by pushing the heart against the anterior chest wall through the intact diaphragm. If no contractions have occurred after sixty seconds, the diaphragm and adjacent pericardium

should be opened, and with the thumb directly on the heart, and the fingers outside the diaphragm, good massage can be accomplished. This method, with the technique of opening the diaphragm just behind the xyphoid process, between the attachments of the two sides of the diaphragm through the avascular area is described by Nicholson.[41]

In instances of cardiac standstill during thoracotomy, direct massage of the heart is by far the best method.[2, 50] Application of Hyman's pacemaker,[31] or Beck's electrodes[2] can be used under direct vision.

The problem of ventricular fibrillation is essentially one of stopping cardiac motion by shocking it into standstill, and then reshocking it into a more normal action.[2, 30] Calcium gluconate intravenously may be used to decrease the sensitivity of the heart, and sodium iodide may be used intravenously to increase the sensitivity, with resultant cardiac motion.

The foregoing suggested outline of treatment may be utilized at advanced medical installations. In all cases of casualties, without obvious cause of death, and with no discernible heart action, immediate energetic action may truly be lifesaving. The mere establishment of an unobstructed airway, institution of artificial respiration, and mechanical stimulation of the right auricle with a needle, may, if done promptly, revive seemingly hopeless patients.

ACUTE EMPYEMA

Acute empyema during the early part of the influenza epidemic of 1917-1918 treated by early open drainage carried an average mortality of 30.2 per cent.[18] In some camps it reached 90 per cent.[44] As a result of the investigation of Graham and Bell,[18] certain principles were elucidated, and treatment of empyema based on those principles reduced the mortality to 4.3 per cent. In view of present war conditions and the possibility of the outbreak of epidemics of influenza with streptococcal pneumonias and resultant empyema, the principles outlined by Graham and Bell should be reviewed, in order that we may not repeat the errors made during World War I.

The principles are: (1) Drainage, but with the careful avoidance of an open pneumothorax during the period of active pneumonia; (2) early sterilization and obliteration of the cavity; and (3) maintenance of nutrition of the patient.[19] The fact that the majority of the patients in army camps died as a result of an open pneumothorax (operative) during the period of an acute pneumonia was the basis for the investigation which resulted in the change in the method of treatment. During the period of acute streptococcal pneumonia, which was so prevalent in the army camps, the vital capacity was markedly lowered, and the patient was then subjected to an additional lowering of vital capacity by the establishment of an open pneumothorax. When this plan of treatment was followed, the mortality was exceedingly high. As a result simple aspiration during the pneumonic stage was substituted.[18] This was done as often as every three to four days. However, dyspnea from accumulation of large amounts of pleural fluid must not be permitted to occur. When the patient has recovered from the stage of acute pneumonia and the empyema is localized in one portion of the pleural cavity and the pleural fluid removed is frank pus, open drainage can be safely performed. By this time, the vital

capacity has greatly increased. The changing character of the fluid is a good index of what is occurring, and when it has definitely changed from a thin, slightly cloudy fluid to frank, thick pus, one may rightly feel that there is a considerable stiffening of the mediastinum and adequate drainage of the empyema should be accomplished.

Both the intercostal catheter drainage and drainage by rib resection have their advocates, and satisfactory results are obtained by the proponents of each method. The important consideration is the appreciation and application of the principles involved in the proper treatment of acute empyema rather than dogmatic statements about a particular method. The avoidance of an open pneumothorax during the acute stage of the pneumonia is of paramount importance. Adequate drainage of the localized empyema must then be instituted.

Obliteration of the cavity is a fundamental principle of treatment. Chemical sterizilation by irrigation every two to four hours with Dakin's solution liquefies the necrotic material and permits it to drain more readily. No chemical can sterilize a cavity without completely free drainage. Recently, it has been shown that the addition of solutions which lower surface tension to Dakin's solution, aids the latter in the liquefying process and tends to enhance its sterilizing qualities. Such detergent substances have been described by Petroff and Schain.[43] The cavity should be measured daily, if a bronchopleural fistula is not present, and the tube must not be removed until the cavity measures less than 10 c.c. The removal of the tube before the cavity is obliterated is an important cause of the development of chronic empyema. The maintenance of the nutrition of the patient by the intake of a high caloric and high vitamin diet supplemented by blood or plasma transfusions is essential.

CHRONIC EMPYEMA

Chronic empyema must of necessity be mentioned in any discussion of war injuries, for the majority result from ill-timed and poorly planned early treatment. Keller,[33] in reporting on a large series of chronic empyema following World War I, found that 75 per cent had accessory pockets, 15 per cent had foreign bodies (drainage tubes and bismuth paste), and 90 per cent had osteomyelitis of the ribs. These were all residual cases in which hemolytic streptococci were found. Too early open drainage was done in a vast majority of instances instead of awaiting localization of the empyema. Many cases, therefore, suffered a total empyema to start with, and of these the majority had inadequate drainage so that pockets developed and remained. If the principles of treatment as outlined in the section on acute empyema are followed, there will not be a large group of chronic empyemas following World War II. For detailed consideration of chronic empyema, the reader is referred to the work of Keller[33] and Graham.[19]

FOREIGN BODIES

In any operative procedure wherein the pleura is explored, all foreign bodies should be removed. In the emergency treatment of sucking wounds of the chest, the removal of foreign bodies should be secondary to immediate strapping of the wound. In such instances the foreign body can be removed during the surgical closure.

In general, foreign bodies in the parenchyma should be removed. However, the mere presence of a foreign body in the parenchyma is not alone an indication for its removal. Foreign bodies lodged in the pulmonary parenchyma in patients who have recovered and are apparently well should be studied carefully in base hospitals, and the treatment must be individualized. As a rule, if the foreign body is a single bullet, there is less chance of it eventually causing complications, than if the foreign bodies are shrapnel, shell fragments, or multiple splinters. Retained foreign bodies often result in late pulmonary suppuration.

In any condition causing prolonged pulmonary suppuration, surgeons should become foreign-body conscious. Drainage tubes are the most frequent offenders. Tubes should be pierced with a safety pin, so that if red rubber radio-opaque tubes are not available, the tube can be located by x-ray. With this in mind, it is well not only to fix drainage tubes securely, but also to state clearly in his medical record the fact that such tubes are used on a person.

COMBINED ABDOMINOTHORACIC WOUNDS

Combined wounds of both thorax and abdomen are not infrequent and they carry a high mortality. In World War I this type of wound was found in 4.6 per cent of all chest injuries.[38] In the Spanish Civil War these wounds constituted 11 per cent of all abdominal wounds. Heyd[28] reported a mortality of 60 to 75 per cent during World War I. From reports of World War I by Gordon-Taylor,[17] prognosis is usually worse if the point of entrance is in the abdomen. Penetration of a hollow viscus, hemorrhage from the spleen or liver, or evisceration are the most common grave possibilities.

The treatment of simultaneous wounds of the chest and abdomen often present a difficult problem. It is desirable to close the thoracic opening before the abdomen is explored through the abdominal wound. This permits the correction of disturbed cardiorespiratory physiology, and the patient's vital capacity will be increased. It is to be remembered that in wounds of the chest the upper abdomen may be spastic and pain may be referred to the abdomen without any involvement of the abdominal contents.[3] In the closure of such wounds it is important to trace the course of the bullet and to inspect the diaphragm. It may be that there is an open wound of the chest with a rigid but intact abdomen in which the contained viscera is involved and the bullet remains in the abdomen. In such cases exploration of a large portion of the abdomen can be conducted through the thoracic wound by merely enlarging the opening in the diaphragm. Certain wounds of the stomach, liver, and intestines can be managed through such an approach. The repair of diaphragmatic tears is essential. The replacement of abdominal organs herniated up into the chest through the diaphragmatic opening helps restore the proper cardiorespiratory physiology. Various techniques for closure of diaphragmatic hernias, as described by Schiffbauer,[48] Harrington,[25] and Truesdale[51] may be used.

CHEMOTHERAPY

Wounds of the chest, like wounds in any region of the body, will respond, to a large degree, according to whether or not infection supervenes. One of the epochal events in medical progress since World War I was the introduction of

the sufonamide drugs. Recent studies have proved this remarkable series of dye derivatives to be valuable in the prevention of infection as well as in the control of sepsis, and to have a local bacteriostatic effect that makes them of paramount importance in the prophylaxis of wound infections. In the present war the role of the sulfonamide drugs in this respect may transcend anything we are prepared to believe with our present limited perspective based only on the more or less ideal surgical circumstances of peacetime experience. A consideration of the sulfonamide therapy of war wounds of the chest, therefore, necessitates a discussion of both the systemic and the local application of the drugs. For the present, the accepted representatives of the sulfonamide group for surgical purposes are sulfanilamide, sulfathiazole and sulfadiazine.

The remarkable reduction in infection rate in a series of compound fractures, published by Jensen and others in 1939,[32] treated by the local implantation of sulfanilamide, marked a new era in the treatment of wounds, and opened an entirely new vista for this amazing drug group. Their results were quickly corroborated by others. Key and his group[34, 35] carried out experiments, proving that the drug has no deleterious effects on the tissues, and does not delay wound healing. Experience was consistent in acknowledging the marked decrease in wound infections when sulfanilamide was introduced into the wounds. Intrathoracic wounds, however, produced a unique set of circumstances. Here, as in no other region, large, unobliterable cavities are likely to be encountered, and more important, one frequently has to deal with the "open bronchus," which serves as a perpetuating source of virulent, drug-refractory anerobic pathogens. Cognizant of these difficulties, Burford and Graham[11] implanted the drug in a series of total pneumonectomy and pulmonary lobectomy cases. It was found, as expected, that the drug did not prevent the development of an empyema, if the bronchus opened, but that the streptococcal component of the bacterial flora was inhibited and frequently eradicated, and for that reason perhaps the severity of the process seemed frequently less severe. There was some indication that contamination of the pleural space at the time of operation was less likely to result in empyema, if the drug was used, provided, of course, the bronchus did not open. No damage to the pleura or pericardium occurred, and very high hemic concentrations of the drug were promptly obtained.

The exigencies of war surgery will of necessity frequently leave much to be desired from the standpoint of impeccable technique, and trustworthy asepsis. It is here that the sulfonamides will doubtless prove invaluable. It is our belief that any chest wound whether intrapleural or of the chest wall alone should have the benefit of this added precaution, sulfonamide locally, even though contamination is known to be minimal. Never, however, should the anticipated use of the drug entice one into a false sense of security, and a consequent lowering of the standards of proper wound handling.

Whether sulfanilamide or sulfathiazole should be used is a matter that would be easier to decide if one could be sure of the invading microorganism. Sulfanilamide is probably more efficacious against the streptococci, and sulfathiazole is certainly more lethal to the staphylococci. Some prefer to use a mixture of equal parts of sulfanilamide and sulfathiazole.

The amount of drug used will vary with the type and extent of the wound. For example, one gram would be sufficient for a laceration of one or 2 inches of the chest wall and not involving the pleural cavity, while as much as 12 or 15 Gm. could be placed with impunity in the space left by a total pneumonectomy or pulmonary lobectomy. In using larger amounts, it is to be remembered that the drug is absorbed very rapidly, particularly from the pleural space, and high blood levels are reached very quickly. If a large dose is implanted, the development of a methemoglobinemia should be anticipated and properly dealt with.

All those experienced in the local use of the sulfonamides are agreed that it in some unexplained fashion tends to increase the likelihood of bleeding and hematoma formation. Particular care must, therefore, be taken to achieve completely adequate hemostasis. In this regard, it is mandatory to remember that it is usually unwise to introduce the drug into the pericardial cavity, unless contamination has been excessive. Not only does the drug frequently occasion disturbing alterations in cardiac rhythm when dusted on the epicardium, but its use is almost certain to occasion a collection of fluid which may cause a serious degree of cardiac tamponade. If the drug is placed in the pericardial cavity, drainage is obligatory. In all cases wherein large amounts of dye are placed in the pleural cavity, the resultant pleural pressure changes must be carefully observed and promptly adjusted. These dyes act as hypertonic solutions, causing the development of pleural effusions. When the pleural cavity is not drained postoperatively, the occurrence of effusion with accompanying mediastinal shift may cause dyspnea proportional to the amount of the effusion. Aspiration of a sufficient portion to permit the patient to breathe comfortably is indicated. It is unnecessary to empty the chest completely for return to normal dynamics can be effected with removal of only 200 to 300 c.c., when there may be a total of as much as 2,000 c.c. By this method, the majority of the fluid remains with its high concentration, and the effectiveness of the drug is utilized without deleterious pressure effects.

The sterilization of the drug previous to implantation into wounds has been the subject of considerable discussion, and while sterilization is highly desirable, it is not absolutely necessary, and we have no hesitancy in using the unsterilized powder if the facilities for autoclaving are not available. Most of the commercial preparations are now supplied in sterile ampoules.

Once infection has supervened, then, of course, the systemic role of the drugs must be relied upon. In infected wounds of the chest, sulfonamide is promptly indicated in adequate doses just as in infection elswhere. In this regard, we wish to emphasize that the continuance of sulfonamide therapy with the neglect of proper surgical drainage, once pus has formed, can only lead to disaster.

We are certain that the prophylactic administration orally of sulfonamide, preferably sulfathiazole, will do much to minimize or to prevent the development of pneumonitis in cases of pulmonary atelectasis, which are not promptly re-aerated. These cases are not infrequently associated with severe chest trauma. It is our practice to give sulfathiazole promptly in all such cases when there is the least doubt that complete pulmonary re-expansion has occurred.

ANESTHESIA

Anesthesia employed in thoracic surgery in wartime may be considered in relation to its use in intrapleural and extrapleural surgery, as well as to its availability in various army installations.

The following can be used in extrapleural surgery: local (novocain), sodium pentothal, ether, nitrous oxide, and oxygen with or without ether and cyclopropane. All the anesthetic agents, except cyclopropane, will be available at evacuation hospitals. Cyclopropane will probably be reserved for the numbered and named general hospitals.

The anesthetics, which can be employed in intrapleural surgery are: cyclopropane, nitrous oxide and oxygen, ether, sodium pentothal, and spinal nupercaine (1:1,500). Nitrous oxide, oxygen, and ether, and sodium pentothal will be used as near the front as necessity requires. Nupercaine (1:1,500) or Jones solution has received more enthusiastic acclaim by the British.

While a trained anesthetist is a boon to the abdominal and orthopedic surgeon, he is an absolute necessity to the thoracic surgeon. A general knowledge of the anesthetic agents and methods of administration usually suffices for abdominal and orthopedic surgery. At least, it may be stated that with a minimum of knowledge untrained personnel may administer anesthetics for abdominal and orthopedic surgery in the press of war. However, anesthetists administering anesthesias in intrapleural surgery must have not only thorough knowledge of the physiology of respirations but also sufficient experience to cope with the many disturbances of the cardiorespiratory mechanism which may occur.

In considering premedication, morphine and scopolamine are the drugs of choice. Many patients will have received morphine sulfate during the first aid treatment and this must be kept in mind in any further premedication. We prefer scopolamine to atropine sulfate because the former has a sedative action that the latter lacks. Soldiers who have had a large meal before trauma or shock occurs, will, because gastric motility is decreased, retain the food in an undigested state. Lavage may be necessary before the anesthetic is started.

Nerve block with novocain can be used in extrapleural procedures. The pain of fractured ribs can be relieved by intercostal nerve block.[46] Large extrapleural wounds are readily managed by local injections. Simple rib resections are easily accomplished under novocain anesthesia. Gas casualties with chest wounds can be readily managed by local anesthesia.

Intravenous sodium pentothal is now a well-established method and forms a valuable adjunct to the anesthetist's armamentarium. Gas anesthesias are widely used. Ether is the most universal. Nitrous oxide, oxygen, and ether makes possible adequate oxygenation by the reduction of the concentration of the nitrous oxide used. It is otherwise impossible to control robust men without some form of anoxia when nitrous oxide and oxygen alone are used. Cyclopropane is particularly adapted to chest surgery because it is given with a high concentration of oxygen. Cyclopropane has nearly replaced ethylene, which is lighter than air and does not give the depth of anesthesia that is possible with cyclopropane.[22]

Proper endotracheal anesthesia has made possible the modern advances in intrapleural surgery. With a carefully developed technique the anesthetist can completely control the patient's entire respiratory cycle and can maintain the proper intrapulmonic pressure at all times.[21] A further very important consideration is that in cardiac standstill the primary factor in cardiac resuscitation is satisfied. Adequate oxygenation through an open airway is thus assured. The special advantages of such a closed system are that it regulates intrapulmonary pressure, controls respirations, and conserves body heat.

Once the chest has been opened, pressures of from +6 to +8 cm. of water are necessary.[40] This maintains sufficient inflation to produce a vital capacity which is above a dangerous level. The amount of pressure should not be a matter of approximation but should be carefully checked by a manometer. The water manometer of Flagg or the graduated weights of Connell are excellent. If these are not available, a simple manometer may be constructed by inserting a measured length of tube into a column of water (Barach). This prevents the raising of the intrapulmonary pressures beyond dangerous limits, even though the bag may be suddenly and forcibly compressed by the anesthetist.

One of the most recent developments has been the use of controlled respirations.[21] It is a great boon to the operator if the patient is under the control of the anesthetist. The rate and depth of respirations can be regulated and stopped and started at the will of the anesthetist. During repair of the diaphragm, manipulation of the mediastinal structures, and suture of the parenchyma of the lung, the movement of the lung may be stopped for a period sufficient to do careful minute work. The technique of controlled respirations, as introduced by Guedel,[21] is reported by Neff and associates for use in thoracic surgery.[40]

In front line surgery it is conceivable that intratracheal anesthesia will not be available. In such instances a tightly fitting face mask will be of value. Any mask with an inflatable cushion will be efficacious (Connell's or McKesson's).

Cyclopropane and oxygen is the anesthesia of choice in intrapleural surgery. The principal advantages of cyclopropane are the high oxygen content, the ease of induction, and the lack of irritation to the lungs and other organs of the body. In our experience there has been little effect on the blood pressure. A rise of over 20 mm. of mercury is the exception. The one disadvantage of cyclopropane is its explosive quality. This is mentioned because it has been overemphasized. Greene states that "Under the same clinical circumstances ether and oxygen, with or without nitrous oxide has the same great tendency toward propagating a wave of flame or pressure through the respiratory tract as has ethylene-oxygen and cyclopropane-oxygen."[20] This is confirmed by the report of the committee appointed by the American Society of Anesthetists to investigate the hazard of fires and explosions due to anesthetic agents. They emphasized that nitrous oxide oxygen and ether is just as explosive as cyclopropane. The principal advantages of ether and air are that it has a relatively small tendency to propagate a wave of flame or pressure down the respiratory tract, even though explosions of ether and air can cause death. By the closed method of administration small amounts of ether are necessary for anesthesia so it is less irritating. This is particularly true when ether is used to supplement nitrous oxide and oxygen. Addition of a small quantity of ether enables the anesthetist to increase the oxygen percentage in the mixture. Ether alone or in

gaseous mixtures gives the untrained personnel a large margin of safety so that it is relatively safe. However, ether is still unpleasant to the patient and the induction period is longer than with gases.

Sodium pentothal intravenously with 100 per cent oxygen by the intratracheal McGill tube is a more recent idea in thoracic surgery. Sodium pentothal has been used extensively, and even the most ardent advocates of nitrous oxide are now using sodium pentothal. After the endotracheal tube is inserted, a cocaine spray through the tube is necessary to abolish the bronchial reflexes initiated by the operator's manipulations. It is always advisable to administer oxygen to the patient under sodium pentothal, since there is a gradual depletion of oxygen in the circulating blood.

Regardless of the type of anesthesia, oxygen by the nasal catheter introduced into the oropharynx should be continued postoperatively for a few days. While intravenous fluids are given from the beginning of the operation, plasma and whole blood will be indicated postoperatively; if plasma or whole blood has been given during the operation, they may have to be repeated. Of course, the patient should be kept comfortable with morphine. This should be ordered as the indication arises. At no time should the respirations or cough reflex be allowed to become too depressed by medication. Carbon dioxide by inhalation is given in the treatment of atelectasis.

SUMMARY

The proper management of thoracic war injuries is a timely subject. The mortality of such injuries has always been high and many persons surviving such injuries have suffered prolonged chronic illness due to extrapulmonary or intrapulmonary complications. In order to decrease these hazards it is necessary that the medical officer called upon to treat such injuries understands the basic principles of the abnormal thoracic physiology resulting from chest wounds. The methods of treatment outlined in this paper are based upon these principles.

The first essential in the management of thoracic war injuries is the immediate care of such wounds. This requires the closure of sucking wounds, control of hemorrhage, and relief of a tension or pressure pneumothorax. This immediate treatment must be followed by early definitive treatment supervised by personnel qualified in thoracic surgery working in properly equipped medical installations where casualties with chest wounds are concentrated within a few hours after the injuries are incurred. All subsequent treatment must likewise be supervised by competent thoracic surgeons.

The treatment of shock in chest injuries requires the same close attention as in other injuries producing shock. It is imperative, however, that immediate attention must be given to correcting the abnormal thoracic physiology. The sources of hemorrhage and the methods of controlling such hemorrhage has been detailed. A wound producing an open pneumothorax or sucking wound of the thorax must be immediately closed. Concurrent and later therapy must conform to the principles outlined in correcting the abnormal physiology. A tension pneumothorax must be relieved. A simple method for accomplishing the decompression is by introducing a large bore needle into the corresponding pleural

cavity, preferably in the second intercostal space anteriorly 2 inches lateral to the sternal border. Care must be observed to prevent obstruction of the lumen of the needle. The recognition of massive pulmonary collapse and treatment directed toward re-expansion of the involved pulmonary tissue will greatly lessen the complications which frequently follow this condition. The phenomenon of bomb blast or "blast lung" has been discussed with a view of enabling its recognition and of preventing unnecessary surgical intervention. The management of cardiac concussion, cardiac wounds, and a rather detailed presentation of cardiac resuscitation have been described. The importance of an understanding of the fundamental principles underlying the proper treatment of acute empyema has been stressed. Foreign bodies in the pleural space should always be removed as early as possible. Many foreign bodies in the pulmonary parenchyma will require subsequent operations for their removal, and each case should be carefully investigated by employing all available aids in the localization of the foreign body before surgical exploration. The sulfonamide drugs should be employed in all thoracic injuries and operative procedures. The anesthetic agents employed in thoracic surgery and the utilization of these agents in war wounds of the chest have been discussed. The recognition of properly employed endotracheal anesthesia will, it is believed, be highly successful in the management of many chest wounds. Likewise the greater use of cyclopropane is considered advisable. Finally, modern thoracic surgery was born during World War I, and has grown to maturity during the past two decades. It is reasonable to predict that its proper employment will contribute to greater developments of this new field of surgery, that many lives will be saved, and that chronicity will be minimized.

REFERENCES

1. Beck, C. S.: Wounds of the Heart; Technique of Suture, Arch. Surg. **13**: 205, 1926.
2. Beck, C. S.: Resuscitation of Cardiac Standstill and Ventricular Fibrillation Occurring During Operation, Am. J. Surg. **54**: 273, 1941.
3. Bennett, R. H., and Burbank, B.: Acute Abdomen During Pneumothorax Therapy, Am. Rev. Tubere. **41**: 50, 1940.
4. Berry, F. B.: The Treatment of Injuries to the Chest, Am. J. Surg. **54**: 280, 1941.
5. Bigger, I. A.: Heart Wounds; Report of Seventeen Patients Operated Upon in Medical College of Virginia Hospitals and Discussion of Treatment and Prognosis, J. Thoracic Surg. **8**: 239, 1939.
6. Blades, B.: Emergency Treatment of Traumatic Chest Injuries, Surgical Clin. North Amer. **20**: 1473, 1940.
7. Blades, B., and Kent, E. M.: Individual Ligation Technique for Lower Lobe Lobectomy, J. Thoracic Surg. **10**: 84, 1940.
8. Boland, F. K.: Traumatic Surgery of the Lungs and Pleura; Analysis of 1,009 Cases of Penetrating Wounds, Ann. Surg. **104**: 572, 1936.
9. Bourne, W., Leigh, M. D., Ingles, A. N., and Howell, G. R.: Spinal Anesthesia for Thoracic Surgery, Anesthesiology **3**: 272, 1942.
10. Bright, E. F., and Beck, C. S.: Non-penetrating Wounds of the Heart; Clinical and Experimental Study, Am. Heart J. **10**: 293, 1935.
11. Burford, T. H., and Graham, E. A.: Local Use of Sulfanilamide in the Pleural Cavity, J. Thoracic Surg. **11**: 203, 1941.
12. Cordelli: As quoted by Thompson and co-workers.[50]
13. Dean, D. M., Thomas, A. R., and Allison, R. S.: Effects of High Explosive Blast on Lungs, Lancet **2**: 224, 1940.
14. DeBakey, M.: The Management of Chest Wounds, Surg., Gynec., & Obst. **74**: 203, 1942.
15. Elkin, D. C.: Emergency Surgery of the Heart, Am. J. Surg. **46**: 551, 1939.
16. Foster, J. M., Jr.: Treatment of Lung Penetrations, Tr. West. S. A. **48**: 476, 1939.
17. Gordon-Taylor, G.: Chest Surgery in War: Abdomino-Thoracic Injuries, Brit. M. J. **1**: 862, 1941.

18. Graham, Evarts, A.: The Medical Department of the United States Army in World War I, Vol. XI, Surg. Part 2. Office of the Surgeon General, U. S. Army.
19. Graham, Evarts A., Singer, J. J., and Ballon, H. C.: Surgical Diseases of the Chest, Philadelphia, 1935, Lea & Febiger.
20. Green, B. A.: Hazards of Fire and Explosions of Anesthetics in Presence of Cautery, Surg., Gynec. & Obst. **74**: 259, 1942.
21. Guedel, R.: Cyclopropane Anesthesia, Anesthesiology **1**: 13, 1940.
22. Guedel, R.: Inhalation Anesthesia, New York, 1937, The Macmillan Co.
23. Hadfield, G., and Christie, R. V.: Case of Pulmonary Concussion (''Blast'') Due to High Explosive, Brit. M. J. **1**: 77, 1941.
24. Hadfield, G., and Christie, R. V.: Blast From High Explosive: Preliminary Report on Ten Fatal Cases, With Notes on Identification and Estimation of the Carboxyhaemoglobin in Formal Fixed Material, Lancet **2**: 478, 1940.
25. Harrington, S. W.: Diaphragmatic Hernia: Symptoms and Surgical Treatment in 60 Cases, J. A. M. A. **101**: 987, 1933.
26. Harrington, S. W.: Diagnosis and Treatment of Various Types of Diaphragmatic Hernia, Am. J. Surg. **50**: 381, 1940.
27. Heuer, G. J.: Traumatic Asphyxia, With Especial Reference to Its Ocular and Visual Disturbance, Surg. Gynec. & Obst. **36**: 86, 1923.
28. Heyd, G.: Thoraco-Abdominal Injuries: Some Technical Procedures Developed by War, Ann. Surg. **72**: 370, 1920.
29. Hyman, A. S.: Intra-auricular Puncture, J. A. M. A. **97**: 408, 1931.
30. Hyman, A. S.: Resuscitation of Stopped Heart by Intracardial Therapy: Experimental Use of Artificial Pacemaker, Arch. Int. Med. **50**: 283, 1932.
31. Hyman, A. S.: Resuscitation of Stopped Heart by Intracardial Therapy: Further Use of Pacemaker, U. S. Nav. M. Bull. **33**: 205, 1935.
32. Jensen, N. K., Johnsrud, L. W., and Nelson, M. C.: The Local Implantation of Sulfanilamide in Compound Fractures: A Preliminary Report, Surgery **6**: 1, 1935.
33. Keller, W. L.: The Treatment of Chronic Empyema Where Recognized Surgical Procedures Have Failed to Produce Obliteration, Ann. Surg. **76**: 549, 700, 1922.
34. Key, J. A., and Burford, T. H.: The Local Implantation of Sulfanilamide in Compound Fractures. Its Effects on Healing, South. M. J. **33**: 449, 1940.
35. Key, J. A., Frankel, C. J., and Burford, T. H.: The Local Use of Sulfanilamide in Various Tissues, J. Bone & Joint Surg. **22**: 952, 1940.
36. Koontz, W. B.: Revival of the Human Heart, Ann. Int. Med. **10**: 330, 1936.
37. Krohn, P. L., Whitteridge, D., and Zuckerman, S.: Physiologic Effects of Blast, Lancet **1**: 249, 1942.
38. Lee, B. J.: Wounds of the Abdomen, The Medical Department of the United States Army in the World War, Vol. 2, Chap. 15, p. 466, Washington, D. C., Government Printing Office, 1927.
39. Morelli, E.: The Treatment of Wounds of Lung and Pleura, Translated by Davis, L., and Irving, F. C., Boston, 1920, W. M. Leonard.
40. Neff, W., Wilson, P., and Gunn, G.: Anesthesia for Pneumonectomy in Man, Anesthesiology **3**: 314, 1942.
41. Nicholson, J. C.: Cardiac Massage, Brit. M. J. **2**: 385, 1942.
42. O'Reilly, J. N., and Gloyne, S. R.: Blast Injury of Lungs, Lancet **2**: 423, 1941.
43. Petroff, S. A., and Schain, P.: Enhancement of Bactericidal Properties of Well Known Antiseptics by Addition of Detergents, Quart. Bull., Sea View Hosp. **5**: 372, 1940.
44. Preliminary Report by Empyema Commission, Camp Lee, Petersburg, Va. J. A. M. A. **71**: 366, 433, 1918.
45. Roberts, J. E. H., and Tubbs, O. S.: Recent Experience With War Wounds of the Chest, Am. J. Surg. **54**: 289, 1941.
46. Rovenstine, E. A., and Wertheim, H. M.: Therapeutic Nerve Block, J. A. M. A. **117**: 1599, 1941.
47. Sante, L. R.: Massive Collapse of the Lung, J. A. M. A. **88**: 1539, 1937.
48. Schiffbauer, Hans E.: Traumatic Diaphragmatic Hernia: Transpleural Repair, California & West. Med. **50**: 180, 1939.
49. Thompson, S. A., and Birnbaum, G. L.: Phenomena of Asphyxial Resuscitation, Proc. Soc. Exper. Biol. & Med. **4**: 203, 1941.
50. Thompson, S. A., Birnbaum, G. L., and Shiner, I. S.: Cardiac Resuscitation, J. A. M. A. **119**: 1479, 1942.
51. Truesdale, P. E.: Diaphragmatic Hernia; Its Varieties and Surgical Treatment of the Hiatus Type, Am. J. Surg. **32**: 204, 1936.
52. Warburg, E.: Subacute and Chronic Pericardial and Myocardial Lesions Due to Non-Penetrating Traumatic Injuries, London, Levin & Munksgaard, 1938, and Brit. Heart J. **2**: 271, 1940.
53. Zuckerman, S.: Experimental Study of Blast Injuries to Lungs, Lancet **2**: 219, 1940.
54. Zuckerman, S., and others: Discussion of Blast Injuries, Proc. Roy. Soc. Med. **34**: 171, 1941.

WOUNDS OF WARFARE*

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WOUNDS produced by the stone club of prehistoric man or by the tusk of the saber-toothed tiger or mammoth were probably the first pathologic conditions observed by man in which the etiology was known. It is almost unbelievable that we should know so little about them today. A thoughtful reading of the historical aspects of the treatment of wounds is obligatory to a proper understanding of the philosophy of the subject. Without this one cannot well evaluate the modern suggestions for the management of wounds. With every war there is a revival of interest in the methods of caring for wounds, since there is produced a laboratory for observation and experiment. Up to the time of Lister many worth-while suggestions based upon empirical observations were made and discarded. Infection in wounds was not a matter of paramount importance to the early writers on Surgery. Hippocrates, Celsus, Franco, and Paré did not emphasize its frequent or fatal occurrence. It is probable that in their day infection was neither inevitable nor serious.

Serious infection in wounds is first commonly mentioned in the surgical writings of the eighteenth century. It is significant that at this time hospitals had been established in which the wounded were congregated for treatment *en masse*. Accounts of hospital gangrene, erysipelas, and putrid infections then made their appearance in the surgical literature. While many surgeons made important observations on treatment, it remained for the founding of bacteriology by Pasteur and its application to surgery by Lister to bring some rationale to the treatment and prevention of infection in wounds. The students of Lister established the principle of antisepsis that acted potently upon the bacteria found in the air, on the patient, and in the exudates. Carbolic acid and its successors were the forces that were to abolish bacteria from wounds of accident or intention. Through the antiseptic to the aseptic era enormous progress was made and modern surgery originated. Pus remained an emblem of defeat, however, and it was washed, irrigated, drained, and neutralized by a great number of chemical agents. With the progress of civilian surgery, surgeons became more complacent and infection had apparently been conquered.

World War I shook us from our smug satisfaction by presenting to a generation of surgeons, who thought wound infection a condition of the Dark Ages, a clinic in which all wounds suppurated. Accepted techniques and chemicals were suddenly powerless. There were at first many attempts to find new and more powerful antiseptics. The failure of these methods led to a realization that wound repair like growth comes from within and that the surgeon can only

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aid nature to limit and to destroy infection. Without enumerating all the steps by which this change in viewpoint came about, one can state that at the end of the war it was the object of the surgeon to convert the wound produced by the missiles of warfare to a clean one. This was accomplished by removing foreign bodies and dirt of the battlefield along with devitalized tissue. This operation, carried out in the stage of contamination, was called débridement. The historical aspects of this operative procedure, originating with Baron Larrey, need not be elaborated here. It was finally realized that the state of the patient himself played an important part in the end result. It became apparent that lost blood must be replaced, shock must be overcome, and malnutrition must be corrected. Wounds already infected were treated in the later period of that war by several methods, all of which gave good results. The French employed a modification of Ollier's methods developed by him in the Franco-Prussian War. The principles of these methods included free drainage, thick absorbent covering, immobilization, and infrequent dressings. Carrell and Dakin's treatment, with frequent irrigation of a wound with hypochlorite solution combined with meticulous dressings, had many advocates. In the British Army the use of hypertonic salt or magnesium sulfate solutions was popular and efficacious. Free drainage and rigid fixation of the part were fundamental to all methods.

In the years that have intervened, surgery has made great progress in the scientific study of factors that influence the processes of repair. Much has been learned concerning the bacteriology of infections and the use of chemotherapeutic drugs. An appreciation of the inhibitory effects of malnutrition has resulted in new concepts concerning the role of vitamins and hypoproteinemia in wound healing. Dr. Winnett Orr improved the Ollier technique and applied it successfully to the treatment of osteomyelitis and infected wounds of bones and soft parts. This method was used with remarkable results by Trueta in the Spanish Civil War. All these advances in our knowledge are applicable to wounds produced by any means and will be briefly reviewed.

The capacity for regeneration and repair as related to wound healing involves certain fundamental principles. To speak of the wounds of warfare categorically and to consider them apart from the traumatic and surgical wounds of civilian life may lead to certain omissions in the consideration of the general features of wound healing.* The influence of selective, purposeful mechanical pressure on wound healing has been discussed by Blair.[3] He has emphasized that pressure limits the amount of plastic substance that pours into the wound, prevents stasis, controls oozing, and eliminates dead spaces. Twyman[4] has demonstrated that epithelium proliferates readily when subjected to pressure that restrains the growth of connective tissue. For a rise in temperature of 10° C. the rate of cicatrization may be increased twofold.[5, 6] Other factors include the influence of electricity, radiant energy, diet and metabolism, vitamins, hormones, and the sympathetic nervous system.

*Quantitative factors may vary with the size of the wound and with wounds of different individuals and different species. Other well-known qualitative factors exert a potent force on the rate of healing. The accelerated healing observed in younger individuals indicates that healing in the young is more rapid than in adults because fibroplasia begins earlier.[1, 2]

The divers factors influencing such basic phenomena as fibroplasia, inflammation, and regeneration deserve more careful consideration than, perhaps, the empirical use of certain therapeutic drugs. Likewise, the reparative processes which follow wounds of mechanical, chemical, electrical, or thermal agencies do not need individual consideration, since there is little difference in the injuries inflicted.

Variations in terrain may influence the bacteriologic flora of the soil, and the increased mobility of the front presents problems in transportation which may result in delay in treatment. The indiscriminate mass attacks directed against densely populated cities, coupled with the increased effectiveness of air forces, have often resulted in a multiplicity of wounds and numbers of wounded out of proportion to existing facilities for their care. The increasing range of artillery fire, combined with the mobility of the front and the omnipresent airplane in turn, tends to limit the type and the amount of operating permissible at the front. Notwithstanding these difficulties, the general features of wounds remain the same from the physiologic standpoint, and those of warfare do not differ in any basic respect from those of civilian life.

WOUND INFECTION

Approximately 75 to 80 per cent of all wounds in modern warfare occur as a result of low velocity projectiles from artillery fire.* The type of wound commonly received is lacerated and contused, usually contaminated by foreign bodies, and requires extensive débridement to facilitate its healing and to avoid systemic infection. Unfortunately, it is true that many wounds escape contamination at the time of infliction only to become grossly contaminated before definitive treatment is completed.

(a) *Bacteriology.* If one divides the organisms introduced into the wound at the time of infliction from the organisms introduced at some later date, the former may be referred to as primary infection and the latter as secondary infection. It is significant that the organisms found in a primary infection are relatively nonpathogenic and grow poorly in unaltered blood or tissues. They will multiply, however, and produce clinical signs of infection when there is devitalization of tissue and when the antitryptic power is lessened by the breakdown of leucocytes. This is especially true of the spore-bearing anaerobic bacilli associated with gas gangrene and tetanus. These organisms are capable of producing infection and toxemia only when there has been alteration of blood and tissues. The hemolytic streptococcus is rarely present at this stage. The source of the primary infection is usually from the soil, the skin, or the clothing. The missile itself is frequently sterile. In the soil, in the air, and on clothing most of the bacteria are relatively nonpathogenic as compared to the hemolytic streptococcus.

*The value of physical prophylaxis of wounds is apparent from the fact that cranial wounds have been reduced from an incidence of 15 to 3 per cent since the introduction of the steel helmet. It is significant that the great majority of wounds are caused by small irregular missiles of low velocity. Although the armor necessary to protect against high velocity bullets may weigh as much as 20 pounds, compressed fiber or bakelite panels (with the same tensile strength as aluminum and one-half the weight) will suffice for protection against shrapnel and trench-mortar splinters. It is logically assumed that many chest and abdominal wounds, which in the past have been caused by low velocity missiles, may be prevented by the use of some form of lightweight body armor.

Secondary infection is of greater clinical import, these infecting bacteria reaching the wound through other agencies. Hemolytic streptococci are usually spread from patient to patient by the personnel caring for the wounded. In the last war it was shown that at the casualty clearing station only 15 per cent of the wounds exhibited the presence of the hemolytic streptococcus, but after a week at a base hospital over 90 per cent of wounds were infected with this organism. Droplet infection from the nose and throat, infected dust, instrument, and bed linens are important contributing factors. It has been shown that if the floor is treated with crude liquid paraffin or with certain proprietary preparations, subsequent sweeping of the floor does not cause large numbers of streptococci to appear in the air from infected dust.[7] In pre-Listerian days the spread of *B. pyocyaneus* through a surgical war was well known, since its presence was revealed by the characteristic color. The spread of *B. pyocyaneus* from patient to patient is not usually a matter of great moment to the patient, since this organism is of low virulence, but it is of the utmost importance as an illustration of some of the failures in technique in the care of wounds.

(b) *Operative Technique.* The success or failure of any débridement depends on the persistence in the wound of nonviable tissue or gross foreign matter. Although as early as 1897, a German surgeon, P. L. Friedrich, published experimental work emphasizing the treatment of contused wounds as if they were neoplasms, the factor of vitality of tissues as the decisive element in infection has not been given its due importance.[8] In the Franco-Prussian War only 9 per cent of the wounds were caused by shellfire and approximately 90 per cent by bullets.[9] With the development of modern warfare, the ratio has been almost completely reversed. Approximately 75 to 80 per cent of all wounds in modern warfare occur as a result of low velocity projectiles and, therefore, require débridement.

The ideal for which one must strive is to make a clean wound out of a dirty one and above all else not to make it any dirtier. Without appearing didactic one may enumerate sound surgical principles which have stood the test of time. Excessive trauma and rough handling of tissue with improper instruments may only serve to increase the amount of devitalized tissue, thereby defeating the primary purpose of the débridement operation. Failure to obliterate dead spaces and the mass ligation of tissue likewise contribute to the incidence of infection rather than help to prevent it. The indiscriminate use of irritating chemicals in the wound should be vituperatively condemned as an agency capable of increasing the devitalization through coagulation of protein substances in the cells.

Suture materials should be chosen with care. The reiteration of the theme that one type of suture will persistently give good results in the hands of anyone is to be condemned. Rather more emphasis should be placed on the effects of trauma, tension, incomplete hemostasis, and a consideration of various pathologic conditions. Well-controlled experiments[10] emphasize, however, that all sutures are foreign bodies and as such should be used sparingly. Foreign bodies when implanted into tissue normally cause a reaction characterized by leucocytic infiltration, the accumulation of serum and fibrin, increased heat, and

even swelling. A foreign body reaction superimposed upon attempts at repair in a healing wound will delay the onset of fibroplasia, and infection will be more frequent. Theoretically, then the ideal suture is one that causes the least reaction in tissues, thus allowing the normal prompt initiation of fibroplasia. When healing is complete, the suture should either disappear from the tissues, or if nonabsorbable, its continued presence should not prove objectionable.

Many objections raised in the past in regard to catgut pertain primarily to its large size. If the smaller sizes of chromic catgut are used with interrupted sutures, many objections which in the past have been reiterated will no longer be tenable. In this connection it is well to point out that there appears to be little indication for the use of plain catgut in any situation. The intensity of the leucocytic reaction incited by its presence is roughly twice as great as in the instance of chromic catgut, and in certain instances its holding strength is negligible in three or four days. The difference in cellular reaction between the absorbable and nonabsorbable sutures may in part be attributed to the large caliber of catgut which was frequently used. It is obvious that no reason exists for the use of suture material with a tensile strength in excess of the holding power of the tissue itself.

There is no great difference in cellular reaction when silk, cotton, steel wire, or nylon is used. However, cotton appears to possess certain advantages. Cotton has a natural twist which is maintained after implantation in tissue, and, therefore, there is less of a tendency for granulation tissue to infiltrate the interstices of the individual fibers to serve as a possible nidus of infection or as a source of a draining sinus. In addition, cotton being a vegetable fiber is chiefly cellulose whereas silk is mainly protein. In general, proteins incite more reaction than nonprotein substances. From an economic standpoint cotton possesses other advantages: a mile of cotton costs about 50 cents, while a similar length of catgut would cost somewhere around $200! The threatened impending shortage of silk need cause little concern among the many proponents of nonabsorbable sutures inasmuch as cotton appears to fulfill the criteria for an all-purpose suture. It does not delay the onset of fibroplasia, and its continued presence in the wound is not objectionable. Even in the presence of grossly contaminated wounds, the development of a draining sinus or extrusion of the sutures is almost never seen.

Stainless steel wire appears to be a suture material which is tolerated extraordinarily well by tissues. It is practically impossible to attribute any type of quantitative reaction to its presence in either experimental or clinical studies. Since 1937 it has been used for suturing the fascial layers in approximately 95 per cent of several thousand laparotomies at the University of Michigan with excellent results. It has never been necessary to remove them from an infected wound, and the incidence of infection itself has been substantially lowered by its use. Similar experience is related by Jones of the Cleveland Clinic, who reports a diminution in the incidence of infection in combined abdominoperineal wounds from 28 to 2 per cent directly attributed to the use of stainless steel wire in the abdominal wound.[11] It is easily sterilized, resists deterioration, and should lend itself well to the requirements of military surgery.

There are certain instances, however, where the use of catgut will definitely lead to inferior results. Nonabsorbable sutures are an integral part of standard techniques of tendon suture which have resulted in substantial improvement in this phase of surgery, as noted by many surgeons. O'Shea's study of 870 cases of severed tendons has shown that the use of catgut was followed by suppuration in 15 per cent, whereas when silk was used, the incidence was reduced to 3 per cent.[12-15]

(c) *Skin of Patient.* The adequate preparation of the skin before beginning débridement is just as important as in an operation for appendicitis. Utilization of "skin technique" and isolation of the wound margins with drapes will result in a diminution in the introduction of secondary invaders into the wound. That the skin is a potent source of contamination is apparent from the experiments of Carraway.[16] In clean laparotomy wounds bacteriologic studies made on the knife blade employed in the initial skin incision yielded positive cultures in 20 per cent of the instances.

(d) *Hands of Personnel.* The benefits accruing from vigorous and methodical scrub scarcely need mention. This one procedure, along with the wearing of sterile gloves, has probably contributed more to improvement in wound healing than in any other single factor. Wherever it is possible, aseptic technique should be rigorously preserved. Even slight compromises in technique are certain to jeopardize results.

(e) *Air of the Operating Room.* Bacterial dissemination in the air of the operating room is influenced by a wide variety of factors. The whispering and talking of traffic and galleries increase the bacterial count tremendously and emphasize the need for the wearing of masks by all who enter the operating theater. The care of the floors and walls where a large number of patients are being treated is important to prevent the spread of infecting agents. The good results obtained by the sterilization of air either by formaldehyde (Gudin[17]) or ultraviolet light (Gardner and Hart[18]) illustrate the importance of keeping the bacterial count of the air of the operating room at minimal levels.

(f) *Nose and Throat of Personnel.* At one time Meleney found that 30 per cent of his operating team harbored hemolytic streptococci in their *noses.* This serves to illustrate the necessity for covering the nose as well as the mouth with some type of serviceable nonpermeable mask. Many masks in common use are notoriously ineffective in this regard, since they allow free permeation of bacteria through the interstices of the material. Epidemics of upper respiratory infection among the operating personnel will frequently result in an increase in the incidence of wound infection unless the strictest precautions are observed. Meleney has shown that from 35,000 to 60,000 bacteria may fall upon the operating field in one hour.[19]

MANAGEMENT OF THE WOUND

Where these principles are observed, excellent results will be obtained. Only the most enthusiastic of idealists would deny that the conditions of warfare will frequently preclude adherence to these well-founded fundamentals. However, when compromises in technique must be granted, it is important to recognize them as such and to plan accordingly in the management of the wound. Sur-

geons of evacuation hospitals soon become specialists in débridement, but their experience should not be obtained at the expense of the early wounded. Successful débridement will be accomplished only through a sound knowledge of anatomy and the general features of wound healing. It must include excision in mass of all torn, crushed, discolored and noncontractile muscle, along with loose bodies and devitalized bone. Primary closure of these wounds may be undertaken only exceptionally, and it is here that judgment and experience are of prime importance.

Ogilvie,[20] in an excellent discussion on the treatment of wounds, carefully divides the progress of wound infection into two stages: contamination and infection.

In the first stage, contamination, bacteria which have been carried in by the inflicting agent lie on its surface, in bits of dirt, clothing, fragments, or in blood clot. This is the stage in which the bacteria can be removed by thorough mechanical cleansing.

In the second stage, infection, the bacteria profiting by the culture medium available have multiplied and started to invade the host. For practical purposes the stage of contamination may be considered as lasting eight hours before it passes into that of infection. Methods of closure are governed by the age of the wound, an estimation of the degree of contamination, and the general facilities at hand.

(*a*) *Primary Closure.* The state of the patient's skin and clothes and the appearance of the wound will aid in an estimation of the probable degree of infection. Doubt as to the condition of the wound should always incline one to pessimism rather than to mistaken optimism. Primary closure may be undertaken only exceptionally when the skin edges come together without tension, when the wound is seen very early, and when there is opportunity for continuous and careful observation of the patient subsequently. In addition, the contamination should be minimal and facilities for adherence to the strictest operative asepsis should be at hand.

Recent observations in actual battle conditions are as follows:

"A large proportion of wounds have been operated upon in the forward area. The recognized débridement was carried out in as many early cases as possible. The wounds were saucerized, sulfanilamide was dusted on the surface, followed by a vaseline dressing or loose pack. *All these cases did extremely well.* Some wounds had been sutured, but with the exception of a very few cases, *were badly septic on arrival at the base*, with sutures cutting out and in pain from suppuration under tension."

The same remarks are applicable to amputation. Those with complete skin closure have seldom met with success. They likewise have arrived at the base hospitals with the sutures cutting out, the skin sloughing, and with pus in the deeper tissues. Amputation under battle conditions should be planned, if possible, to permit of reamputation at one of the sites of election. Whenever possible, flaps should be cut and allowed to fall over the end of the stump.

(*b*) *Delayed Closure.* A delayed type of primary closure may occasionally be utilized in the wound that has gone beyond the rather arbitrary eight- to

twelve-hour limit.[21-24] A simplified technique for carrying out this procedure in dirty wounds has been described in a previous publication.[25] The skin sutures are placed at the time of the débridement but are not tied, and a pack left in the wound for a twenty-four-hour period will set up an inflammatory reaction in the subcutaneous layers. Clinical experience indicates that this inflammatory reaction enhances the ability of the wound to deal with the subsequent development of infection. Little, if any, disadvantage results from leaving the skin unsutured for two or three days. If the wound remains comparatively sterile, delayed primary suture is a means of diminishing the period of hospitalization with reduction of disability.

Secondary suture may likewise be employed in certain selected cases. A septic wound of the soft tissues in the course of about fourteen days is usually relatively clean if proper treatment has been carried out. By this time necrotic tissue has separated, and the granulation tissue has assumed a healthy appearance. Information as to the bacteriology of the wound may be obtained by suitable laboratory procedures.

It is probably advantageous to clean carefully the wound with continuous wet dressings for two or three days before performing secondary closure.

It is becoming more and more evident that the best dressing for any raw surface is skin. Even though the new skin is merely a temporary covering to be later replaced with another type of graft for functional or cosmetic reasons, its early use may avoid weeks of pain along with disability from scar tissue contracture. The healing of extensive raw surfaces by secondary scar formation should be avoided wherever possible.

Padgett and Hood,[26] of the University of Kansas, have perfected a calibrated mechanical device for cutting large sheets of skin at virtually any predetermined level. Whereas the Thiersch graft as cut with the hand knife may vary from 0.010 inch to 0.018 inch, the dermatome graft of Padgett may be cut in any range of thickness from 0.008 to 0.024 inch. A full thickness skin graft in an adult varies in thickness from 0.032 to 0.040 inch. The "three-quarter" thickness graft is cut at a level 75 to 90 per cent of the thickness of the skin. The degree of contraction of the base of a wound is proportional to the thinness of the overlying graft. In some areas a thin graft may contract as much as 60 per cent. Many objections raised in the past to split-thickness grafts are invalidated when this thicker type of graft is employed as cut with the dermatome. The ease with which it may be used makes virtually anyone proficient in this particular phase of surgery.

ROLE OF SULFONAMIDES IN WOUND HEALING

It has been estimated (Colebrook) that streptococci are responsible for at least 70 per cent of all deaths subsequent to wound infection. Only 15 per cent of wounds culture streptococci within twelve hours, but at the end of a week of hospitalization the incidence increases to about 90 per cent. Droplet infection from the nose and throat, infected dust, instruments, and bed linens are important contributing factors. It seems, therefore, that if sulfanilamide were present in the circulating blood at the time the organism reaches the tissues, a systemic

infection might be prevented. There is reason to believe that the sulfonamide group of compounds have a high value in combating and preventing infection in wounds. Their systemic use after the wound is infected and after operation in the stage of contamination as a prophylactic measure is well established.

Sulfanilamide as a topical application for wounds was first used in the Spanish Civil War. The results of such treatment, however, were lost when Barcelona was captured with disorganization of the entire medical service. Reports from France reveal that sulfanilamide was used in the French Army, applied directly to wounds as a prophylactic measure. It has, of course, been used subsequently in both civilian and military surgery, with some difference in opinion as to its general effects. Where the number of wounded is out of proportion to the facilities at hand for their care, it has been shown through recent military experience that the local use of the sulfonamides may prevent the transition of the stage of contamination to that of infection. In such an instance débridement may be utilized after the eight- or twelve-hour arbitrary dead line rather commonly employed in the past.

Jensen and his associates[27, 28] were the first in this country to publish observations on the topical use of sulfanilamide in wounds. They demonstrated "that sulfanilamide is more effective when implanted locally than when given systemically in preventing wound infection. Local sulfanilamide will not prevent infections in the presence of massive doses of contaminating organisms, although it does appear to lessen the severity of these infections.

"Devitalized tissue will inhibit the activity of locally implanted sulfanilamide. Foreign matter will protect the contaminating organisms against sulfanilamide." Chemotherapy is no substitute for careful surgical débridement, immobilization of the part, and skillful general aftercare. More carefully controlled studies are necessary to the final evaluation of locally applied sulfa chemicals in lengthening the time element when débridement can be done in contaminated wounds. There is no substitute for meticulous operative treatment done at the earliest possible time. In both the immediate and postoperative care of the wounded man, it is well established that the general nutrition of the patient is extremely important. Shock, hemorrhage, dehydration, and starvation must be treated and overcome. Especially important is hypoproteinemia that may result from malnutrition, hemorrhage, or from a septic course with much exudation. Proper diet, transfusion, plasma, and amino acid mixtures must be used to correct this nutritional abnormality.

It has been shown that a proper vitamin intake is essential to orderly wound healing. Vitamin A is related to epithelial cell growth; vitamin B complex apparently influences proliferation of fibroblasts; vitamin C plays an important part in collagen formation and in fibroblastic growth. A food intake rich in these essentials is necessary for tissue repair.

Much remains to be learned from the observations and tests of experience, but we now face the care of those suffering tissue injury with more assurance. The scientific studies of the past two decades have given us a sound foundation on which to build new and better techniques.

REFERENCES

1. Lecomte du Noüy, P. E.: Cicatrization of Wounds, J. Exper. Med. **24**: 451, 1916.
2. Lecomte du Noüy, P. E.: Une mesure de l'activité physiologique, Compt. rend. Soc. de biol. **109**: 1227, 1932.
3. Blair, V. P.: The Influence of Mechanical Pressure on Wound Healing, Illinois M. J. **46**: 249, 1924.
4. Twyman, E. D.: Epithelial Proliferation. Differential Pressure as an Aid in the Growth of Epithelium on a Denuded Surface, J. Missouri M. A. **19**: 257, 1922.
5. Ebeling, A. H.: Cicatrization of Wounds, J. Exper. Med. **35**: 657, 1922.
6. Ebeling, A. H.: A 10 Year Old Strain of Fibroblasts, J. Exper. Med. **35**: 755, 1922.
7. Fleming, A.: Bacteriological Examination of Wounds, in Bailey, H.: Surgery of Modern Warfare, Edinburgh, 1941, E. & S. Livingstone, pp. 141-149.
8. Trueta, J.: The Treatment of War Fractures by the Closed Method, Proc. Roy. Soc. Med. **33**: 65, 1939.
9. Lyle, H. H. M.: The Principles of the Surgery, Hospitalization, and the Evacuation of the Wounded in the Meuse-Argonne Offensive, Mil. Surgeon **84**: 580, 1939.
10. Farris, J. M.: Tissue Reactions to Suture Materials, Ann. Surg. **114**: 159, 1941.
11. Jones, T. E.: Complications of One Stage Abdominoperineal Resection of Rectum, J. A. M. A. **120**: 104, 1942.
12. Bunnell, Sterling: Repair of Nerves and Tendons of the Hand, J. Bone & Joint Surg. **10**: 1, 1928.
13. Bunnell, Sterling: Primary Repair of Severed Tendons. The Use of Stainless Steel Wire, Am. J. Surg. **47**: 502, 1940.
14. Mayer, Leo: Repair of Severed Tendons, Am. J. Surg. **42**: 714, 1938.
15. O'Shea, Maurice C.: The Treatment and Results of 870 Severed Tendons and 57 Severed Nerves of the Hand and Forearm, Am. J. Surg. **43**: 346, 1939.
16. Carraway, C. N.: Some Causes of Occasional Infections in Clean Abdominal Cases, South. M. J. **22**: 554, 1929.
17. Gudin: Asepsie fictire et sterilisation totale, Presse méd. **44**: 355, 1936.
18. Gardner, C. E., and Hart, Deryl: Recent Advances in Surgery from a Bacteriological Viewpoint, Surgery **1**: 458, 1937.
19. Meleney, F. L., and Stevens, F. A.: Postoperative Haemolytic Streptococcus Wound Infections and Their Relation to Haemolytic Streptococcus Carriers Among the Operating Personnel, Surg., Gynec., & Obst. **43**: 338, 1926.
20. Ogilvie, W. H.: Treatment of Wounds, Brit. M. J. **1**: 132, 183, 1938.
21. Buxton, S. J. D.: Injuries of the Lower Limb: I., Brit. M. J. **1**: 1241, 1939.
22. Lauwers, E.: Traitement des plaies cranio-cerebralis par projectiles, Presse méd. **48**: 30, 1940.
23. Leriche, R.: Apres l'exision des plaies musculaires par projectiles de guerre, suture primitive, platre ou suture retardee, Presse méd. **48**: 1, 1940.
24. Weddell, J. M.: The Treatment of Wounds in War, Brit. M. J. **1**: 785, 1939.
25. Coller, F. A., and Valk, W. L.: The Delayed Closure of Contaminated Wounds, Ann. Surg. **112**: 256, 1940.
26. Padgett, E. C.: Skin Grafting, Springfield, Ill., 1942, C. C Thomas.
27. Jensen, N. K., and Nelson, M. C.: Local Sulfanilamide in Compound Fractures, Surg., Gynec. & Obst. **75**: 34, 1942.
28. Jensen, N. K., Johnsrud, L. W., and Nelson, M. C.: The Local Implantation of Sulfanilamide in Compound Fractures, Surgery **6**: 1, 1939.

HEALING OF WOUNDS*

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WOUND healing is a process which intimately concerns every surgeon, but this fundamental subject has received only superficial consideration, for the most part, until very recently when the basic principles have begun to be more widely appreciated. This paper attempts to epitomize the known facts from various angles, basic and clinical.

BIOPHYSICS OF WOUND HEALING

As soon as a wound to tissue is sustained, serum and blood accumulate and coagulate in the wound space and to a lesser degree in the interstices between the surrounding uninjured cells. Into this damaged area, cellular elements of the blood, wandering tissue cells and new capillary loops are attracted. These capillary loops make up granulation tissue which pulls the wound edges together as the fibroblasts mature. This briefly is the entire process of normal healing and it is dependent on certain fundamental phenomena, namely: ameboid movement of cells, mitotic proliferation of cells and maturation of cells engaged in fusion of wound surfaces. Ameboid movement of cells is stimulated by the presence of blood, tissue fluids and a large number of other substances. Inadequacy of oxygen and nutritive substances in the relatively ischemic border of the wound may cause tissue hunger and anoxia followed by cell division and ameboid activity of fibroblasts and endothelial buds. Immediately after tissue injury the lytic phase of wound healing begins and here the dead tissue elements are removed by phagocytes. This also is called the lag phase because reparative processes do not begin until toward the end of the lytic phase. Phagocytosis is followed by an influx of wandering connective tissue cells and then proliferation of the invading fibroblasts begins. Now, two fundamental processes begin to operate. The stereotropic response of growing cells to surfaces causes the growing fibroblasts to elongate along the fibrils of the fibrin network in the coagulum, filling the wound space just as epithelial cells show ameboid movement along plane surfaces of granulation tissue and beneath crusts. This stereotropic response thus causes the fibroblasts to grow out and invade the wound space on the trellis of fibrin fibrils. A second factor which operates toward the same end is that of centrifugal force which directs growing cells away from their own kind and so into the plasma mass in the wound space. Endothelial buds also exhibit this phenomenon which may be an electrochemical mechanism; like cells with like surface charges tending to repel each other. Wounds become firm as the maturing fibroblasts contract and surface epithelialization progresses. The expected time of healing of any wound readily can be computed mathematically

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using the Carrell-DuNouy[1] formula which is calculated on the basis of surface area. These computations also apply to the healing of granulating cavities such as those seen in empyema. I have previously shown this to be the case in some unpublished work quoted by Carlson.[2]

SYSTEMIC CONDITIONS INFLUENCING WOUND HEALING

1. Tissue age, whether adolescent, normal adult, senescent, or degenerated, influences the rate of wound healing not only because young tissues heal most readily but because old tissues are apt to show vascular changes which retard healing. 2. The state of hydration of the tissues as determined by water, electrolyte and protein balance in the blood exerts a profound effect on wound healing, and these factors will be discussed separately and in more detail later. 3. Normal nutritional balance is a somewhat vague term which probably covers the aggregate of many of the other factors which influence wound healing. 4. Vitamin balance will be discussed in detail later and will be found to be one of the most fundamental but least known influences on wound healing. 5. The general state of circulation and blood picture influence wound healing as they affect the interchange of cellular and ionizable elements between normal and damaged tissues.

LOCAL FACTORS INFLUENCING WOUND HEALING

1. There is a quantitative relationship between the amount of killed or damaged tissue in the wound and the time required for phagocytosis and repair. 2. Vascularity of the tissues involved is of prime importance in wound healing. Avascular tissues must depend on lymph spaces for interchange of nutritive and waste materials, and since most authorities deny that lymph flows, this interchange depends upon diffusion gradients for exchange of ionizable substances and ameboid motion for ingress of cells. 3. As a corollary to the preceding statement, the local blood supply to the wound must be intact, for no matter how vascular the tissue, if the blood supply is jeopardized by trauma, healing will be retarded in direct ratio. 4. The amount and character of the exudate in the wound space and in the tissues bordering on the wound determine the rate of healing in large measure. 5. The number and nature of the infectious organisms in the wound space and bordering tissues have a profound bearing on wound healing as infection throws an added burden on the reparative mechanism. 6. The number and type of foreign bodies which must be encapsulated or extruded from the wound influence the rapidity of wound healing.

RELATION OF TISSUE PH TO WOUND HEALING

Normal tissues preserve a neutral reaction by means of diffusion between the blood stream and local tissue spaces. Injured tissue accumulates acid metabolites and the breakdown of dead tissue also liberates split protein products which are acid in reaction. These factors influence the injured area and cause a shift in pH toward the acid side. Menkin[3] shows that neutrophilic leucocytes are attracted to slightly acid areas, and these cells therefore congregate in the injured area. If acidity exceeds the optimum point, the neutrophilic leucocytes are killed and macrophages are attracted. If the macrophages are able to phagocytose enough dead tissue to decrease the acidity, the inflammatory

reaction regresses; but, on the other hand, if the acidity increases, the macrophages also are killed and suppuration results. As the neutral stage is regained, such cells as the lymphocytes and plasma cells migrate to the site of reaction. From this discussion it seems that chemotaxis is largely responsible for the accumulation of the various cellular elements at the site of inflammatory reaction.

ROLE OF VITAMINS IN WOUND HEALING

Vitamin A deficiency causes such clinical manifestations as night blindness, photophobia, dry skin, dry conjunctivae, blepharitis, follicular hyperkeratosis, and numerous or severe infections. This latter may be of some importance in wound healing but such terms as "local tissue immunity" and "site of local lowered tissue resistance" usually are employed only to cover ignorance. About 35 to 50 per cent of people show deficiency in Vitamin A by the photometric test; however, this test is not generally accepted as accurate. About 12 per cent of individuals show clinical deficiency of vitamin A, as evidenced by one or more of the previously mentioned clinical manifestations.

Of the vitamin B complex, B_1 or thiamin chloride seems to be the only factor of importance in the healing process. B_1 seems to be identical with one of the components of the carboxylase enzyme system governing metabolism in nerve tissue. Therefore vitamin B_1 is of importance in the healing of injuries to nerve tissue.

Vitamin C (ascorbic or cevitamic acid) is the most essential vitamin in the healing process because intercellular substance in general and in the capillary bed in particular, as well as the collagen of all fibrous tissue, requires cevitamic acid for its production and maintenance. Lack of vitamin C causes hemorrhage into the wound space with a lag in healing and a tendency to wound disruption. Vitamin C deficiency in experimental animals has been shown to delay return of tensile strength in wounds. About 40 per cent of indigent clinic patients are deficient in vitamin C and all patients over seventy years of age show a relative deficiency. Patients placed on a strict ulcer diet become deficient in vitamin C within four days. These figures are arrived at by using the skin test or the capillary fragility test. Many superficial studies of wound dehiscence have been published and various factors have been blamed, but it seems reasonable and probable that vitamin C deficiency is the most universal and important factor. Vitamin C deficiency has many other interesting implications as has been emphasized recently by Levine,[4] who states that German soldiers receive 100 mg. of crystalline vitamin C daily.

Vitamin D is irradiated ergosterol which is related to cholesterol, one of the group of sterols which are of extreme importance in basic cell physiology because the sterols are responsible for the selective permeability of cell membranes. The presence of these sterols in the surface film enables the cell membrane to change its colloidal state from a water in oil to an oil in water emulsoid and, therefore, both oily and aqueous substances may be taken into the cell selectively.

Vitamin K, a water-soluble naphthohydroquinone, is responsible for maintaining the level of blood prothrombin. K is absorbed from the gastrointestinal tract only in the presence of bile so that in cases of biliary obstruction, K is not

absorbed, the prothrombin level drops and the patient tends to bleed. Vitamin K deficiency is of importance in wound healing only in patients having biliary obstruction.

The story of vitamins is not yet told but this seems to sum up our present knowledge of vitamins as they relate to wound healing.

RELATION OF STATE OF HYDRATION TO WOUND HEALING

Water is necessary to carry nutritive elements and waste products in solution and since these solutions must be isotonic with blood, relatively large quantities of fluid are essential. The many other implications of this important subject have been covered by the papers of Coller and Maddock.[5] Suffice it to say here that either too much or too little fluid retards wound healing. The state of hydration of the surgical patient may be gauged by: 1. The urinary output. 2. Specific gravity of the blood as measured by the falling drop method.[6] 3. The McClure-Aldrich salt edema test.[7] The surgical patient must have a daily urinary output of at least 600 c.c. and preferably 1,000 c.c. The falling drop test measures the concentration of the blood, and by the use of a simple chart blood protein levels may be quickly read off. The McClure-Aldrich salt edema test depends on absorption of skin wheals of normal saline solution, and the rapidity of absorption is an index of the tissue hunger for fluid and salt.

RELATION OF ELECTROLYTE BALANCE TO WOUND HEALING

Sodium chloride is the most important electrolyte and is almost entirely responsible for the osmotic pressure of intercellular fluid. Accumulation of salt in the tissues attracts fluid, edema develops, and edematous tissues do not heal properly because of altered pressure relationships and insufficient ingress and egress of materials. Decreased concentration of salt in the tissues causes a loss of fluid into the vessels with consequent tissue dehydration. Adequate fluid balance, therefore, depends on salt balance, and both are very important in wound healing.

RELATION OF LEVEL OF PROTEINEMIA TO WOUND HEALING

Protein is the most important colloid element of blood, and as the quantitative level of blood protein is decreased, the osmotic pressure and diffusion gradient are so altered that fluid tends to leave the vessels and accumulate in the tissue spaces. Blood protein levels of lower than 5 mg. per cent result in this type of edema. Deficiency of protein as well as edema retards wound healing. Ravdin[8] has shown that abdominal wound disruption developed in over 70 per cent of dogs operated upon in the presence of hypoproteinemia. There was little or no evidence of fibroplasia in these cases up to two weeks after operation. On the other hand, a high protein diet speeds up wound healing and almost eliminates the lag phase.

RELATION OF METABOLIC RATE TO WOUND HEALING

Theoretically, an increase in basal metabolic rate should speed the healing process, but such does not seem to be the case. Goiter incisions in patients with very high metabolic rates do not heal any more readily than other types of

incisions about the neck. Routine administration of thyroid extract postoperatively to speed wound healing and increase the circulatory rate to prevent thrombophlebitis has been advocated but has not proved to be of value.

RELATION OF LOCAL BLOOD FLOW TO WOUND HEALING

Local blood flow brings in most of the cellular elements which are so important in wound healing, brings in nutritive elements, and carries off metabolites. In addition, there is a very important mechanical factor to be considered. If a large vein is damaged, it should be ligated because the thin wall precludes suture, and since veins usually are multiple, sufficient venous channels will remain. If a large artery is damaged, it should be sutured if feasible but if this is impossible, a very different physiological problem arises. Blalock has shown that if a large artery is ligated, its accompanying vein also should be ligated. This procedure has the effect of causing blood to remain longer in the involved area and thus the injured tissues have more time to make use of it. If the artery alone is ligated, the venous channels of return overbalance the arterial supply and the area is drained of blood. Ischemic gangrene may be the result. This is a very difficult point to make, and while many surgeons advocate and teach it, few have the courage of their convictions. The rationale is clear and I have seen it work in practice.

EFFECTS OF TEMPERATURE ON WOUND HEALING

The application of heat to most potentially infected wounds by the use of hot packs, hot water bottles or light cradles is almost universal but may be very dangerous. There may be three serious disadvantages to the use of heat on wounds. 1. Heat may speed up local tissue metabolism to the point where the damaged vessels cannot adequately supply the increased demand for fuel and gangrene results. This is more frequent than is realized in such cases as diabetic infections which progress to gangrene. 2. Heat cannot be carried away because of damaged vessels so that a cumulative effect is present and causes increased tissue damage. 3. Heat augments capillary filtration and so increases local edema which may or may not be beneficial as will be discussed later. It is a safe rule never to use external heat of more than 100 degrees, and a thermometer always should be hung in the light cradle. Refrigeration in the presence of vascular damage probably is more rational than the use of heat. Refrigeration decreases metabolic needs so that a damaged circulation may be adequate. Fay has applied this principle to the treatment of carcinoma because malignant tissue has a higher metabolic rate than normal tissue, and refrigeration may cause death of tumor tissue before normal tissue is affected.

ROLE OF PRESSURE AND TISSUE TENSION IN WOUND HEALING

I previously have shown[9] that in a hollow viscus distention of the lumen or increase in the tissue tension will cut off blood flow sufficiently to cause inflammatory changes within the walls and this will progress to gangrene and perforation even in the complete absence of bacterial infection. Wound healing in other tissues is slowed by increased pressure or tissue tension because of reduction in blood flow or hindrance to physicochemical processes. Brooks[10]

showed that the period of viability of tissues rendered completely anemic by pressure is remarkably constant at 18 hours. The time element seems to be much more important than the degree of pressure because very low pressures may cause gangrene if applied constantly over a long period of time. Edema or external appliances may exert sufficient pressure to cause tissue damage and mild degrees of damage heal by fibrosis which, in such cases as Volkman's contracture, may lead to serious dysfunction.

IMMOBILIZATION AND ELEVATION IN THE TREATMENT OF WOUNDS

Immobilization is a well-established principle in the treatment of fractures, but its benefits in soft tissue wounds are not so generally appreciated. Complete immobilization in soft tissue injuries not only facilitates healing but also relieves pain, prevents deforming contractures and facilitates nursing care. Immobilization for soft tissue wounds was used extensively in the late Spanish War and has been exhaustively discussed by Trueta and others.

Elevation of the injured part makes use of the force of gravity to aid in return of blood and lymph from the site of injury and is an extremely important mechanical principle. The fundamental question as to whether the inflammatory reaction to healing and infection is the result of bacterial action or is a defense mechanism on the part of the host has never been satisfactorily answered. If the former, then treatment should combat the reaction, and if the latter, therapeutic measures should augment the reaction. Edema fluid is said to contain antibodies, and swelling may occlude tissue spaces and inhibit bacterial spread. On the other hand, edema increases pain, decreases circulation, slows healing, and may provide a fluid medium through which bacteria disseminate. Elevation of the affected part definitely reduces inflammatory edema and makes the patient more comfortable. Healing is facilitated but there are two dangers connected with the use of elevation. 1. Elevation of the lower extremity puts an extra load on the vascular system because blood does not flow up hill without work. Particularly in older patients the angle of circulatory efficiency must be watched closely. The toes of elevated extremities should be checked repeatedly for drop in temperature, and the vessels must be palpated for adequate circulation. I have seen a number of cases of gangrene develop from excessive elevation of the leg in young persons. 2. Elevation causes pus to settle by gravity and travel along fascial planes toward the trunk. I have seen several huge gravitational abscesses develop under casts applied with the leg in elevation where the abscess was some distance proximal to the original infection. The papers of Wangensteen[11] discuss the factors of immobilization and elevation in the treatment of wounds in considerable detail.

PRIMARY VS. DELAYED CLOSURE OF WOUNDS

The decision as to whether primary or delayed closure of a wound is to be employed depends on the time that has elapsed since the injury and also on the degree of obvious contamination. Primary closure in a clean wound is indicated up to 8 hours after injury, but recently I have seen wounds of much longer duration, involving tendon suture, primarily closed with good results by implanting

sulfanilamide powder at operation. Ordinarily, however, dirty wounds or clean wounds seen after 8 hours are treated by delayed closure. If the wound meets the criteria for primary closure, it should be flushed with large quantities of saline solution or washed repeatedly with soap and water. Bad habits are difficult to eradicate so that the instillation of so-called antiseptic solutions into wounds still is practiced widely. Closure should be accurate but without tension. Silk sutures may be used in clean cases, but catgut is safer because of the disagreeable sequelae if silk is used in the presence of infection. Catgut has a number of disadvantages, among which may be mentioned the fact that it is a foreign protein and occasions a certain amount of inflammatory reaction during its ultimate liquefaction and absorption. Certain patients absorb catgut very rapidly, and there is some question of allergy in these cases. In wounds which are doubtfully clean, it is possible to place adhesive tape close along the wound edges and then to suture the adhesive instead of the tissue. This procedure makes it a simple matter to open the incision if infection develops. If the wound does not meet the requirements for primary closure, it should be treated in one of the ways to be discussed later and then, when a smear from the granulating surface shows a bacterial count of less than 10 organisms per high power field, secondary closure may be done or the wound may be covered by a skin graft.

DÉBRIDEMENT OF WOUNDS

Contused and multiple lacerated wounds require careful excision of all obviously devitalized tissue because of the danger of infection, particularly by the anaerobic organisms of tetanus and gas gangrene if dead tissue remains to use up oxygen and act as a culture medium. A study of ballistics shows that for various sizes and velocities of projectiles, there are definite areas of tissue on all sides of the injury which subsequently will die as a result of the concussion. Therefore, it is important for the surgeon to know what type of projectile caused the injury in order to determine how much tissue to remove. Poor judgment in this matter may seriously affect subsequent healing.

ANTISEPTICS IN INFECTION AND WOUND HEALING

Many kinds of saprophytic bacteria and higher organisms live on the normal human skin, the number and kind depending on the environment and the degree of personal hygiene of the individual. A clean skin usually shows 12 staphylococci or diphtheroids per square centimeter. Other common organisms in addition to fungi are spore formers, the colon group, and Bacillus proteus. This indicates that all wounds are at least potentially contaminated but simple flushing of wounds with saline solution or soap and water usually suffices to remove these nonpathogenic organisms. However, from time immemorial men have searched for the magic colored solution which will kill bacteria but not harm tissues. Notwithstanding the expensive and varicolored solutions on the market today, such a desideratum has not yet been attained. The practice of pouring these solutions into defenseless wounds simply increases the tissue burden and should be discontinued. Novak[12] showed that all common alcoholic antiseptics kill 96 to 99 per cent of skin organisms, but 50 per cent alcohol plus 10 per cent acetone alone kills 97 per cent. It, therefore, seems irrational to pay

$10 a gallon for certain commercial solutions. Novak made up a solution of 0.5 per cent cresol and 0.07 per cent bichloride of mercury in 50 per cent alcohol and 10 per cent acetone solution. This solution kills 100 per cent of diphtheroids, 99.6 per cent of staphylococci, costs but 60 cents a gallon, and has been successfully used clinically for at least three years at the University of Minnesota General Hospital. Novak solution has been used for skin preparation at the Station Hospital, Ft. Leonard Wood, Mo., since the hospital opened on May 3, 1941, with an extremely low incidence of wound infections.

TREATMENT OF INFECTED WOUNDS

The fact that such a large number of agents have been recommended for the treatment of infected wounds indicates that the ideal method has not been discovered. However, it is well to bear in mind the outstanding points in the use of these various substances.

Dakinization. Dakin's solution is an aqueous buffered solution of sodium hypochlorite which liberates chlorine. Chlorine has the effect of liquefying fibrin, dissolving dead tissue, killing bacteria, and, therefore, is beneficial in any infected wound. The solution has the disadvantages of rapid deterioration, short action, objectionable odor and requires an elaborate system of bottles and tubes for proper use. Dakin's solution dissolves the cornified layers of normal skin and, therefore, the area around the wound must be protected by vaseline gauze. The solution will sterilize a wound in 48 hours if correctly used and will transform pus into a transparent, mucinous substance with only a slight choline odor. Azochloramide is a more stable preparation which liberates chlorine over a longer period and consequently is less irritating to normal tissue. Dichloramine T is an oily preparation which disintegrates still more slowly. Dakin's solution was extensively used in the last World War, but it is predicted that it will be little used in the present war.

Maggot Treatment. Maggots were first introduced in the treatment of chronic osteomyelitis because it was observed that infested cases were found to be the cleanest. The application later was broadened to include all infected necrotic wounds. There are several ideas as to why the larvae are effective. 1. It has been suggested that the larvae actually eat the dead tissue and purulent exudate, thus mechanically cleaning up the wound. 2. It has been thought that larval excretions are responsible for the healing effect. 3. Dead larvae are thought to liberate a substance which is bactericidal. The use of live maggots is objectionable to patients because of the crawling of the maggots and from the esthetic viewpoint. Furthermore, the treatment is difficult to carry out because it is hard to obtain sterile maggots as needed. The problem has been approached by an effort to isolate the effective principle and by the application of macerated larvae in saline solution or ointment form.[13] Experimental evidence shows that these extracts and ointments definitely promote healing, and at present it does not seem necessary to use live maggots.

Cod Liver Oil. Cod liver oil is very valuable in the treatment of any infected wound and in prophylaxis in any open wound. The oil discourages bacterial growth and has a marked stimulating effect on granulation tissue. There

may be some truth in the claim that vitamin D is the effective agent because it is known that oxidized odorous oil is more efficacious than the highly purified product. Also, irradiation of other oils increases their healing properties. Cod liver oil may be used to fill cavities and soak dressings or may be used as a 30 to 50 per cent ointment in vaseline. Cod liver oil is of great usefulness in the treatment of infected wounds, empyema, chronic osteomyelitis, suppurative arthritis, burns, arteriosclerotic and diabetic gangrene.

Oxidizing Agents. Certain bacteria grow best in an atmosphere of lowered oxygen tension and grow well in symbiosis because one organism uses up oxygen, thus making an anaerobic medium for the other. A microaerophilic streptococcus is such an organism and causes a gangrenous spreading infection. One means of treatment is débridement followed by the application of a substance which breaks down to liberate oxygen. Meleny has popularized the use of zinc peroxide in such cases. This agent comes in powder form which is sterilized and then made into a thin paste with sterile water. The wound then is filled with paste-saturated sponges and a large airtight dressing is applied to inhibit evaporation and to prevent the rapid escape of oxygen.

Chlorophyll. Various vegetable substances recently have been advocated for use in treatment of infected wounds. Of these, chlorophyll[14] has received the widest trial. Chlorophyll inhibits bacterial growth apparently by preventing bacterial enzymic digestion of cell membranes. It is used in aqueous solution or in an oily base for suppositories or ointments. It may be given intravenously, by mouth, or it may be used as an irrigating fluid. Chlorophyll cleans up the wound and stimulates granulation tissue. It has had extensive clinical trial in such cases as wound infections, empyema, fistulas, deep abscesses, acute infections of the nose, throat and ear, male and female urinary tract infections. This substance should be cheap, easy to prepare, and almost universally present. It is interesting to speculate as to what role the vitamins in green vegetation may play in the healing effect of aqueous extracts.

Barberry. Folklore remedies which have stood the test of time deserve scientific investigation in order to isolate whatever specific principle may be present. One example of such work is the recent investigation of barberry by Dick.[15] Barberry has been widely used for centuries by aborigines as an infusion to cure surface infections and gonorrhea. Experimental work shows the effective agent to be berberine, which in 1 per cent solution kills erysipelas streptococci in 8 hours. Clinically, berberine has been successfully used in wound infections, decubitus, and varicose ulcers and mouth infections. It is dangerous when administered intravenously.

Pectin. Another folk remedy of proved worth is the apple diet for infantile diarrhea. The effective agent now is known to be pectin, which is found to be bacteriostatic in aqueous solution and stimulating to granulation tissue. Tompkins[16] and others have shown its worth in the treatment of various wound infections.

Silicon. The use of silicon in the treatment of wounds has a very interesting background. Mountain dwellers of Virginia have a tradition that eating sand will cause peptic ulcers to cease bleeding, and this led to an investigation of

silicon. It is known that silicon in the lung causes intense fibrosis of the pulmonary tissue, and Gardner has shown that this is in inverse ratio to the size of the particles of silicon. It seems established then that silicon promotes fibrosis, and the idea that silicon might cause wounds to fibrose was given a clinical trial with striking results. Silicon was ground to the finest powder and used in all types of wounds and ulcers with prompt healing. Silicon was given by mouth for bleeding ulcers and by cystoscope for bleeding tumors with equally good results. I saw these cases demonstrated in the Department of Surgery at the University of Cincinnati in 1934 and was deeply impressed but to my knowledge the work never was published. They were able to show elevation in the level of blood silicon by oral administration with favorable results in wound healing.

Specific Sera and Antitoxins. Gas gangrene, caused by Cl. welchii, is a frequent complication of war wounds because these anaerobic organisms are almost universally found in dirt. This complication is much dreaded because the gas generated by the organisms rapidly spreads along tissue planes and produces pressure necrosis of tissue. Manson has shown a 35 per cent incidence of Cl. welchii in indolent leg ulcers, and this has given undue alarm to many surgeons doing amputations in cases of diabetic or arteriosclerotic gangrene. In a published series, Kennedy and I[17] have shown that 38 per cent of milk cultures made at operation and at the site of amputation were positive for gas-forming organisms, but in no case was antigas serum given and in no case did gas gangrene develop. This illustrates our point that most of these gas formers are relatively nonpathogenic, and if amputation is done according to the criteria we laid down, favorable results will follow in a higher than usual per cent of cases. Formerly, gas gangrene was treated by massive doses of antitoxin, but its value is open to question, and the danger of foreign protein sensitization is great. Injection of oxygen into the tissues has been used with some success, but the most beneficial treatment seems to be with the x-ray or the local use of sulfanilamide. Tetanus is caused by Bacillus tetani, also a dirt organism, and is the cause of a high mortality rate. There is nothing new in the treatment of this disease, but it is suggested that zinc peroxide, x-ray therapy, and sulfonamide derivatives give enough promise to warrant investigative work. One answer to the problem may lie in the universal toxoid immunization to tetanus now employed by the Army, but some alarming anaphylactic reactions are being reported.

X-ray Therapy. Since the striking work of Kelley in the treatment of gas gangrene, peritonitis, and other severe infections by x-ray therapy, it has been suggested that it be used in the early treatment of war wounds. Keating and Davis[18] suggest that portable x-ray therapy units be placed with mobile surgical hospitals which already have power plants mounted on trucks. All dirty wounds would be treated within four hours after injury. This procedure is not to be recommended for three reasons: 1. Slight overdosage of x-ray therapy delays wound healing and may cause other well-known and more serious consequences. X-ray therapy given in all surgical hospitals would require many more trained radiologists than are available. 2. Not only is there danger of overdosage at one sitting but it is quite likely that in the rush of battle evacuation, records might not be completed so that patients might be treated twice. Such mistakes are not entirely beyond the bounds of possibility. 3. Local implantation of sulfanilamide

is so astonishingly successful in combating wound infection that it should not be discarded in favor of x-ray therapy, and most authorities state that the two modes of treatment should not be employed in the same case.

Sulfonamide Drugs. Sulfanilamide and its derivatives seem to act as bacteriostatics by virtue of their power to prevent bacterial cells from utilizing oxygen. Sulfapyridine was introduced to combat staphylococci, but it is relatively insoluble, gives a higher incidence of gastrointestinal upsets, and now is little used. Sulfathiazole is well tolerated by mouth, in solution in cod liver oil, or in ointment form. Excellent results have been reported from its use in carbuncles, operative wound infections, decubitus ulcers, corneal ulcers, chronic osteomyelitis, empyema and subcutaneous abscesses.[19] However, sulfathiazole is less soluble than the original sulfanilamide which is preferred for local implantation.

Local implantation of sulfanilamide crystals was first used in compound fractures by Jensen,[20] who reduced the previous incidence of severe infections from 25 per cent to nearly zero. Implantation gives a local concentration up to 800 mg. per cent as compared with 10 mg. per cent which is attained with difficulty by oral administration of the drug. This concentration is so great that all organisms are affected, regardless of whether or not sulfanilamide is specific for them. Saturated solutions of the drug may be used to irrigate infected cavities with excellent results. Local implantation of sulfanilamide around complicated gastrointestinal anastomoses[21] has greatly reduced the mortality, and its use free in the peritoneal cavity in cases of peritonitis has been beneficial.

It is to be remembered, however, that sulfanilamide is absorbed with great rapidity from the peritoneal cavity, its maximum blood level often being reached in 15 minutes after implantation. For this reason, the liver may be fatally damaged unless care is taken to use no more than 5 grams of the drug. I have seen three patients die of toxic hepatitis following the intraperitoneal introduction of 10 grams of the drug. It is suggested that every soldier be furnished with 5 gram ampoules of sulfanilamide with instructions to break one and pour the contents into a wound, whatever the site, as soon as incurred. The question of having the soldier begin oral administration of the drug or one of its derivatives also, immediately after injury, should receive earnest consideration.

SUMMARY

Biophysical, mechanical, chemical and bacterial factors are briefly considered as they relate to wound healing. The use of various and diverse substances in the treatment of infected wounds is discussed and numerous points are raised with the hope that additional investigative work will be stimulated.

REFERENCES

1. Carrel, A., Hartmann, A., and DuNouy, L.: Healing of Wounds, J. Exper. Med. **24**: 451, 1916.
2. Carlson, H. A.: Acute Empyema Thoracis, J. Thoracic Surg. **5**: 393, 1936.
3. Menkin, V.: Inflammation, Arch. Path. **27**: 115, 1939.
4. Levine, V. E.: Scurvy, the Soldier's Calamity, The Military Surgeon **89**: 140, 1941.
5. Coller, F. A., and Maddock, W. G.: Water and Electrolyte Balance, Surg., Gynec. & Obst. **70**: 340, 1940.

6. Foote, M. N., and Gerst, G. R.: Practical Application of the Falling Drop Method for Determining Surgical Prognosis, Am. J. Surg. **50**: 316, 1940.
7. Hopps, H. C., and Christopher, F.: The McClure-Aldrich Test in Water Balance Following Operation, Surg., Gynec. & Obst. **69**: 637, 1939.
8. Raydin, I. S.: Hypoproteinemia and Its Relation to Surgical Problems, Ann. Surg. **112**: 576, 1940.
9. Bowers, W. F.: Role of Distention in the Genesis of Acute Inflammation of Hollow Viscera, Am. J. M. Sc. **194**: 205, 1937.
10. Brooks, B., and Duncan, G. W.: Effects of Pressure on Tissues, Arch. Surg. **40**: 696, 1940.
11. Wangensteen, O. H.: Importance of Immobilization and Posture in Treatment of Acute Infections of Extremities, Minnesota Med. **21**: 225, 1938.
12. Novak, M., and Hall, H.: Method for Determining the Efficiency of Preoperative Skin Sterilization, Surgery **5**: 560, 1939.
13. Miles, G., and Farley, R. T.: Comparison of Effects of Sterile Antiseptic Jell With and Without Larval Ingredient on Wounds, Am. J. Surg. **45**: 76, 1939.
14. Gruskin, B.: Chlorophyll—Therapeutic Place in Acute and Suppurative Disease, Am. J. Surg. **49**: 49, 1940.
15. Dick, G. F.: Barberry—Ancient Remedy, New Germicide, Arch. Surg. **41**: 287, 1940.
16. Tompkins, C. A., Crook, G. W., and Haynes, E.: Pectin in Treatment of Various Types of Wounds, Surg., Gynec. & Obst. **72**: 222, 1941.
17. Bowers, W. F., and Kennedy, J. C.: Improved Management in Gangrene of the Foot, Am. J. Surg. **50**: 573, 1940.
18. Keating, P. M., and Davis, F. M.: Prophylactic Treatment of Wounds in War, The Military Surgeon **86**: 235, 1940.
19. Spink, W. W., and Paine, J. R.: Local Use of Sulfathiazole in Treatment of Staphylococcal Infections, Minnesota Med. **23**: 615, 1940.
20. Jensen, N. K., Johnsrud, L. W., and Nelson, M. C.: Local Implantation of Sulfanilamide in Compound Fractures, Surgery **6**: 1, 1939.
21. Varco, R. L.: University of Minnesota, Unpublished data.

WAR WOUNDS AND ANAEROBES

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(The writer states that the views expressed in this article are his own and that neither the Surgeon General nor the Medical Department of the Army is in anyway responsible)

HISTORY

BEFORE we take up the study of anaerobes involved in war wounds let us view the history of the entire anaerobic realm.

In 1776 Spallanzani discovered that certain bacteria could live in an anaerobic environment. In 1861 Pasteur recognized the fact that certain organisms were able to exist and multiply in the absence of free oxygen.

The first of the pathogenic anaerobes to be discovered is the Leptothrix buccalis. Robin isolated and described it as early as 1847. In 1879 it was isolated by Trevesan. Frankel (1882), Michelson (1889), and Epstein (1900) observed leptothrix in connection with inflammations of the mouth and pharynx. Vignal and Arustamoff successfully isolated this organism.

Obermeier, engaged in the study of relapsing fever, isolated an organism which he called the spirillum of relapsing fever. This occurred in 1873. Little further work was done on this spirillum until thirty years later. From 1904 to 1908 various forms were discovered, among them the Spirocheta duttoni by Dutton and Todd in 1905; the Spirocheta dochii by Novy; the Spirocheta

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carteri by Mackie; the Spirocheta vincenti by Blanchard. There are several types of relapsing fever and it is not yet known which types of spirochetes are responsible for the various types of the disease.

Schaudinn (1905) in his researches on Spirocheta pallidum very often found spirillum of very similar morphology. This spirillum is the Spirillum refringens, found in the mouth, tonsils, in ulcerating lesions, in smegma, and in venereal warts. Noguchi (1913), in cultivating various bacteria taken from lesions of the external genitals, discovered a new species, which he called Spironema phagedenae. Another similar anaerobic spirochete had been discovered in 1912 by King and Baeslake; they called it the Spironema hyos.

Framboesia tropica, a disease occurring in tropical and subtropical countries, was studied by Castellani (1905). He isolated from a large number of cases a spirochete which was named Spirocheta pertenue. It occurs in the cutaneous papules and ulcerations accompanying the disease. Von dem Borne repeated Castellani's investigations two years later and confirmed the facts stated by Castellani.

In the same year Schaudinn and Hoffmann carried on a series of investigations with syphilitic patients, examined primary syphilitic indurations and secondary enlarged lymph nodes, and discovered a spirochete which had not been described and which was found in infected syphilitic patients in a great proportion, and which was not found in uninfected patients.

Next to the Spirocheta pallidum comes the Clostridium tetani in interest from the standpoint of pathogenicity. Lockjaw had been known for many centuries, but it was not before 1883 that the causative agent of the disease was discovered. Carlo and Rattone in 1883 discovered it in the pus from a cutaneous lesion of a tetanus patient. They called it the bacillus of lockjaw. Nicolaier (1884) and Kitasato (1889), each carrying on investigations on tetanus, isolated and described a bacillus which is believed to be identical to the one described by Carlo and Rattone.

Van Ermergen (1896) investigated a portion of a pickled ham, the ingestion of which had caused disease of 34 persons, ten of them very seriously. He isolated an organism which he called the Bacillus botulinus. His work was confirmed by Romer (1900). In 1915 Nevin discovered another type of Bacillus botulinus, which he called Bacillus botulinus B.

Babes, Vincent, and Plaut are the chief workers on the disease known as Vincent's angina. In a throat smear of a patient suffering from Vincent's angina, Babes in 1889 isolated the Bacillus fusiformis.

A bacterium found in the stools of nursing children is the Bacillus bifidus, discovered by Tissier in 1900.

Less important are the following: The lymph node anaerobic bacillus, closely related to the bacteria group, also called the Corynebacterium, discovered by Torrey in 1916. The Bacillus egens, discovered by Stoddard in 1919. The multifermentans tenalbus, or Clostridium multifermentans, also discovered by Stoddard in 1919. The anaerobic pseudotetanus bacillus, or Clostridium tetanomorphum, discovered by MacIntosh and Fildes in 1917. Actinomyces necrophorus, discovered by Loffler in 1884, and the Treponema mucosum of Noguchi (1913).

A very extensive study was made of the anaerobic organisms associated with traumatic injuries during World War I. Most of the bacilli had been discovered long before the outbreak of the war, but it was during the war that we learned so much about them. The first of these organisms to be discovered was the Vibrion septique of Pasteur and Joubert (1877). B. welchii found in gas gangrene, usually in civilian cases, was first discovered by Welch and Nuttall (1892). This bacillus has also been called the gas bacillus, Bacillus perfringens, and Clostridium welchii. Another bacillus of this group is B. oedematiens, which infected a large number of wounds, according to the discoverers, Weinberg and Sequin (1915). In the same year Weinberg and Sequin isolated B. fallax, a slightly pathogenic anaerobe. The following year they discovered the B. histolyticus, an intensely proteolytic anaerobe found associated with the anaerobes in war wounds. In 1889, twelve years after Pasteur had discovered Vibrion septique, Cornevin, Arloing, and Thomas found a bacillus which they called the Bacillus chauvoei, the bacillus of symptomatic anthrax or blackleg.

Another organism that Weinberg and Sequin claim to have occurred frequently in war wounds is the B. sporogenes, discovered by Metchnikoff in 1908. In putrid wounds is occasionally found B. putrificus, discovered by Bienstock (1884). The B. sporogenes cadaveris of Klein is perhaps the same as B. putrificus. Tissier and Mortally have found this organism present in putrid meat. The Bacillus oedematiens of Weinberg and Sequin is similar to, but not identical with, Bacillus oedematiens II, or bacillus of Novy, discovered by Novy in 1894.

TECHNIQUE OF ISOLATION

Anaerobic bacilli are comparatively difficult to isolate. It was not until World War I that efficient methods for the isolation of anaerobes were developed. The early workers usually were working with several organisms when they thought that they had a pure culture. MacIntosh and Fildes developed a good method for their isolation by using a technique which involved repeated plating of the anaerobic bacilli. Veillon's method was used by some workers. This consisted of inoculating agar shake tubes with varying dilutions of material. The tube is then filed through at the level of the colony, and the colony is then fished. The best method is Barber's method. (Developed by Barber in the laboratories of the Rockefeller Institute.)

In Barber's method a pipette is used to pipette out the colony. Barber claims that his method is not as time-consuming as the older methods, and permits the observer to make further observations on anaerobiosis, variability, motility, rate of growth, and behavior in a medium of small sowing exactly known than the older methods allowed.

An isolation chamber is used, 7 cm. long, 3.25 cm. broad, and 2 cm. high, which gives sufficient room and allows the use of a large cover glass, 60 by 35 mm. The cover glass must be heated very clean, because it may be used for growing colonies on it. It is carefully cleaned, smeared with vaseline, washed with hot water and alcohol, and wiped with a clean cloth. This leaves a very thin film on the glass. If sterilization is necessary, it should be done over a flame of low temperature so as not to melt the vaseline. The point of

the pipette should be made very fine, just large enough to permit the entrance of organisms. It should be about 5 micra in diameter.

With the aid of a microscope a small droplet is pipetted from a cover slip containing a thin film of the solution with the organism to be isolated. The droplets pipetted off should then be examined under oil immersion. This will insure the purity of the culture insofar as organisms visible to the oil-immersion lens are concerned. Invisible organisms cannot be guarded against.

The isolated organisms are then transferred to test tubes, or grown on cover glasses and then transferred. A fresh pipette is used for each organism, and the organisms are separately transferred to test tubes. Each new pipette has the tip sterilized by supplying same with a small amount of sterile broth before use. This aids also in washing the bacilli well into the tubes in the case where bacilli adhere to vaseline on the outside of the pipette. In washing the bacilli out, the technician must be careful not to blow any air into the culture. The pipette method is used upon seeding material isolated by the usual means. Air was removed by pumping in oxygen or by heating, the culture being covered by a layer of vaseline $\frac{1}{5}$ to 2 cm. thick which prevents access of air. For growing spores in hanging drops, Barber used the following method: A shallow moist glass chamber, 45 mm. long, 25 mm. broad, and 2 mm. deep, is made. The isolated spores are arranged on a cover glass, 1.5 or 2 mm. apart, and sufficient media added. The undersurface of the cover glass, with the exception of the central portion containing the isolated spores, is then covered with a soft glucose agar culture of B. pyocyaneus, about 4 or 5 hours old. The area in the center may be surrounded by a thin paraffin wall to prevent spreading of the pyocyaneus. The bottom of the moist chamber is also supplied with a similar layer of pyocyaneus culture. Pyrogallic acid and KOH were used by Barber in connection with B. pyocyaneus, but they did not offer any advantage. Barber made sowings of the following bacilli: B. sporogenes, B. welchii, B. tetani, B. edematis, B. botulinus, B. of Ghon Sachs, B. aerofitidus, B. putrificus, B. bellonensis, B. tertius, B. fallax, B. edematiens, B. bifermentans, B. histolyticus, Vibrion septique.

Out of 400 one-cell sowings of bacilli, he succeeded in producing growth in 62, or 15.5 per cent.

He made 211 one-cell sowings, using all of the above, with the exception of welchii, edematis, aerofetidus and fallax and producing growth in 93, thus getting as a result 44.1 per cent. For the bacilli he used as media glucose broth, serum glucose broth, semisolid glucose agar, semisolid serum agar, firm glucose agar, firm Veillon agar, liver peptone agar, minced brain, liver peptone water under vaseline, liver peptone water in vacuum, milk and plain broth. For the spores he used in addition, egg cube and meat, but did not use liver peptone agar or minced brain. The bacilli, as a whole, grew best on the various glucose media, the spores on the semisolid glucose agar. Barber also found that spores remained viable after exposure for an hour or more, whereas bacilli were much more rapidly affected, depending on species. Barber found that B. sporogenes grows very rapidly, B. bellonensis very slowly.

In summarizing, Barber made the following statements: "(1) The pipette method has proved a feasible method of obtaining pure cultures of one-cell

anaerobes. (2) Both bacilli and spores may be used as seeding material, but spores give a much higher percentage of positives. Boiling alone affords a sufficient degree of anaerobiosis to the medium for initiating one-cell growth; and semisolid agar is the most convenient form of medium. Exposure to air during isolation apparently has no effect on the viability of spores of anaerobes, but young bacilli of some species suffer from a comparatively short exposure to free oxygen."

CULTURAL CHARACTERISTICS

The cultural characteristics of the anaerobic bacilli causing gas gangrene will be discussed. We may divide these up into two groups, saccharolytic and proteolytic, as follows: saccharolytic, B. welchii, Vibrion septique, B. oedematiens, B. fallax; proteolytic, B. sporogenes, B. histolyticus, B. putrificus.

B. welchii is a gram-positive, nonmotile organism. In older cultures it may become gram-negative. Its length is 4 to 8 micra, breadth 1 to 1.5 micra, straight and usually square. It may be coccus-shaped or rod-shaped, and has a capsule. It has no flagella, no spores, and is not very strictly anaerobic. The surface colonies on nutrient agar, serum agar, or glucose agar are circular in contour. Old colonies are 1 to 2 mm. in diameter. Young colonies, that is, colonies about 12 hours old are translucent. It ferments the common sugars, starch, and may ferment glycerin and inulin. It does not ferment mannite, dulcite, salicin. It grows rapidly on meat, with a formation of acid and gas. In milk we get what is known as stormy fermentation. Acid and gas are formed with remarkable rapidity in great quantities. No spores. In coagulated serum there is no change, no liquefaction, and spores are formed. In alkaline egg broth an opacity results. Gelatin is liquefied in 48 hours in an inoculated tube at 37 degrees Centigrade.

Vibrion septique is gram-positive, composed of slender rolls, strictly anaerobic, has spore formation, is motile, has no capsule. On meat we get a rancidity and gas. On milk, where it is usually found, it causes acidity, produces a little gas, and causes clotting. There is no liquefaction on coagulated serum. Alkaline egg broth growth results in opacity, but there is no clotting. It liquefies gelation. When grown on broth, a turbidity forms which settles to the bottom, leaving a clear supernatant fluid. It will ferment glucose, levulose, galactose, maltose, lactose, and salicin. It will not ferment glycerin, saccharose, inulin, mannite, and dulcite.

It may be differentiated from the B. chauvoei of Arloing, Cornevin, and Thomas by the fact that Vibrion septique will ferment salicin; B. chauvoei will not.

B. oedematiens is motile under strictly anaerobic conditions. It is a stout rod, 0.8 to 1 micron in length, which is somewhat wider than B. welchii. The rod is lightly curved. Autolysis sets in very early in B. oedematiens cultures. Strict anaerobic conditions for good growth are required. In meat we get gas; in milk, acid, and at the end of 4 or 5 days, a clot. Coagulated serum, no change. Broth, a flocculation and a semi-opaque cloud. Gelatin is liquefied. The production of acids is feeble in fermentations. It will ferment glucose, levulose, and maltose. It will not ferment glycerin, galactose, saccharose, lactose, mannite, dulcite, inulin, and salicin.

B. fallax is a motile, slender rod, 3 to 6 micra in length, has rounded ends, and is slightly curved. Gram-negative elements are frequent. When colonies are grown, those on the surface appear as round, crenated, slightly granular. The deep colonies are lenticular, irregular, or bean-shaped. It will not digest meat, but will form acid. In three to seven days a milk culture clots. With coagulated serum there is no liquefaction. The same is true of gelatin. All strains of B. fallax will ferment glucose, levulose, and maltose, but only a few strains will ferment galactose, saccharose, starch, inulin, and salicin.

B. sporogenes is ancillary to the condition of gas gangrene. It is actively motile, slender, forms spores, gram-negative in old cultures, gram-positive in young cultures, and is not absolutely anaerobic. The colonies have a wooly, tangled filament structure on the periphery, and have a hard center. The deep colonies are wooly. On meat there is a vigorous growth, with gas formation, an alkaline reaction, and a putrid odor. In milk a turbidity is formed which settles out, leaving a clear supernatant fluid, the reaction becoming alkaline. Coagulated serum is liquefied. In alkaline egg broth a flocculent precipitate falls to the bottom and is digested. Gelatin is liquefied. It will ferment only glucose, levulose, and maltose. Some of the other organisms ancillary to a condition of gas gangrene are: B. cochlearius, B. parasporogenes (McIntosh, 1917), B. tertius (Henry, 1917, Rodell as B. III of von Hibler as B. IX), B. tetanomorphus, B. aerofetidus, B. bifermentans, B. putrificus, B. butyricus, B. multifermentans tenalbus.

B. histolyticus is motile, rod-shaped, frequently arranged in pairs, is 3 to 5 micra in length and 0.5 to 0.84 broad. Cultural reactions are characteristic for the group. The surface colonies are delicate, flat, crenated, and have irregular edges. In agar the deep colonies are arborescent or corallike, with fine wooly ends to the branches. A white deposit of tyrosine follows digestion upon inoculation in meat. Coagulated serum is liquefied and gelatin is liquefied. Glucose, levulose, maltose-fermented.

B. putrificus is strongly proteolytic, gram-positive rod, oval spores, strictly terminal, giving drumstick appearance. Gelatin and serum are liquefied; milk is digested. It is found in gas gangrene and contributes to the putrid odor, but is in itself not pathogenic.

POWER OF RESISTANCE

In the classification of anaerobes we inquire as to their resistance to an oxygen environment. In viewing the bacterial realm, we notice that we have various groups as regards aerobism. To one of these groups atmospheric oxygen is a toxin. This group is the obligative anaerobe group. Barber's experiments showed that the presence of free oxygen stopped growth as follows: B. welchii, 23 minutes; B. tetani, 60 minutes; B. oedmatis, 10 minutes; B. botulinus, 6 minutes; B. sporogenes, 0 minutes; B. of Ghon Sachs, 6 minutes; B. aerofitidus, 10 minutes; B. putrificus, 1 minute; B. bellonensis, 6 minutes; B. tertius, 10 minutes; B. fallax, 6 minutes; B. oedematiens, 17 minutes; B. bifermentans, 6 minutes; B. histolyticus, 10 minutes.

No culture has ever been grown absolutely oxygen free; a little oxygen is always present. Anaerobes live symbiotically with aerobes to a great extent, and perhaps acquire oxygen in that fashion.

During World War I it was forcibly called to the attention of the clinicians that the resistance of the bacteria to certain antiseptics did not have the same effect on the bacteria in the wound as it did in the laboratory.

Antiseptics of rapid action, which anaerobic bacteria are unable to resist, are Dakin's solution, eusol (hypochlorite solutions), and chloramine T. These antiseptics prevent further growth even in optimum media. With eusol the following figures will show result of action:

TIME EUSOL REMAINED IN WOUND	NUMBER OF COLONIES DEVELOPING	NUMBER OF BACTERIA PER C.C. OF FLUID IN WOUND, CALCULATED
5 minutes	2	200,000
20 minutes	50	5,000,000
30 minutes	40	4,000,000
60 minutes	25	2,500,000

TIME CHLORAMINE T IN WOUND	NUMBER OF COLONIES DEVELOPING ON PLATES
10 minutes	No growth after 24 hours
	Innumerable colonies after 4 days
20 minutes	Innumerable colonies after 4 days
30 minutes	Innumerable colonies after 48 hours
60 minutes	Innumerable colonies after 48 hours

The antiseptics used above are very destructive to anaerobes in the laboratory but their potency is dissipated in some way in the wound perhaps by contact with the walls of the wound, its discharges, or both of these factors. By experiments carried on in vitro it was discovered that the bactericidal efficacy of antiseptics is lessened in the presence of serum, and that leucocytes have a quenching effect upon antiseptic agents. The values for the concentrations of various drugs to inhibit completely the growth of B. sporogenes are as follows: Iodine 1:500; chloramine T 1:50; carbolic acid 1:200; mercuric chloride 1:2,000; crystal violet in 6,400. For B. welchii the values are as follows: Iodine 1:500; eusol 1:4; chloramine T 1:60; carbolic acid 1:200; mercuric chloride 1:2,000; malachite green 1:200; flavine 1:16,000; crystal violet 1:1,000. Dyestuffs in general exert an inhibitory effect on the bacteria. The bactericidal dyes lose a great deal of their potency by combining with the fabrics used for bandaging.

Anaerobes, and especially their spores, are comparatively resistant to desiccation. Light is a strong bactericidal agent, but in the case of the anaerobes, a completely anaerobic environment will interfere with the bactericidal action of light. Hydrogen peroxide is a strong bactericidal agent.

A hypertonic salt solution is an indirect bactericidal agent; it produces an accumulation of leucocytes. Electric light, x-rays, and radium light have an inhibitory effect on anaerobic growth. Electrical currents applied to a solution containing anaerobes will act as a bactericidal agent. Heat will kill anaerobes.

CHANNEL OF INFECTION—MOST COMMON SOURCE

The point of infection is the wound. Of the various types some are more liable to anaerobic infection than others. The more irregular and lacerated wounds become more highly infected. In the case of a wound caused by a shell particle acute infection follows for two reasons: The shell particle makes a rougher wound than the high-powered bullet, and the shell bursting on percussion with the ground carries with it as it enters the wound portions of soil,

which in highly fertilized districts may be heavily charged with anaerobes. Infection may take on various phases. We may get a localized anaerobic infection in the wound, slowly spreading anaerobic infection in the wounds; gas gangrene of the "group" type when a single muscle or group of muscles is attacked; gas gangrene of the massive type when a whole segment of a limb is involved; or the fulminating type.

Infection is aided by the following factors: Retention of extravasated blood; interference with the local circulation; the presence of masses of devitalizing tissues; extensive fractures and comminution of long bones; retention of wound secretions by dressing, pastes, or packings. The wound, if it has the shape of a cavity with a small surface opening, is ideal for anaerobic growth. Delay in the mechanical cleansing of a wound leads to acute infection, as does also the retention of foreign bodies.

PATHOGENICITY

In a wound a myriad of factors enter which determine whether an anaerobic infection will be apparent within an hour, or whether several days will elapse before distinctive features appear. An infection usually takes the following course: The wound has a brownish discharge, composed of broken down blood clots; it is foul smelling and gives off gas. The odor depends on the infecting organism and the stage of the wound. At the very beginning a characteristic smell is absent, but later it becomes foul and acrid. A serous infiltration occurs throughout the intermuscular septa and connective tissue. The accumulation of the fluid causes a swelling which takes on the appearance of a purplish ring around the wound. The muscle is at first not infected; when infection sets in, we have the condition of gas gangrene. The muscle tissue is invaded by the organisms and is gradually digested. If the blood supply is left intact, we are able to see the actual course of infection. The muscle becomes black, friable, and diffluent. Then we get several color zones, first red, then yellow. Contractility is lost and the muscle undergoes changes in coloring, beginning with red and changing to greenish yellow and then to black.

In another type the blood supply is cut off. The muscle changes color from purplish red to a greenish black diffluent mass. Gas forms first as bubbles between the muscle fibers, afterwards entering the areolar tissues. The gas has a deleterious effect, since it produces pressure in the fascial sheath and constricts the blood vessels. Interference with the blood supply is very favorable to infection, because neither the first nor second line of defense is given free play.

Toxin Production.—B. welchii produces a true exotoxin. An antitoxin was first developed by Klose (1916), which was not, however, as effective as Bergston's. Since B. welchii is the chief organism involved in gas gangrene, an antitoxin injection will remove the organism causing the most trouble, and will leave the minor gas gangrene organisms alone, among them the Vibrion septique and B. oedematiens, which come next on the list from the point of view of infection. B. welchii was isolated by Weinberg and Sequin in 72 to 80 per cent of the cases of gas gangrene studied by them during the war.* Pathogenicity and hemolytic power vary greatly with the different strains of B.

*World War I.

welchii. In fatal cases death usually results from a B. welchii septicemia. Spores are never formed in the animal body.

Vibrion septique has a very powerful toxin. It is a soluble toxin. A specific antitoxin has been developed.

B. oedematiens is, in general, pathogenic, although two nonvirulent strains have been isolated by Weinberg and Sequin. The lesion caused by B. oedematiens is characterized by a whitish, gelatinous exudate and absence of gas. B. oedematiens forms a soluble toxin, but does not cause the acute infection that Vibrion septique does.

B. fallax is very slightly pathogenic.

B. sporogenes was found in 27 per cent of the cases examined by Weinberg and Sequin; it is usually responsible for the foul odor in wounds. This organism is, however, not very pathogenic and produces a weak toxin.

B. histolyticus is intensely hemolytic and produces large lesions, but is nontoxic, and does not produce acute infections.

B. putrificus is actively proteolytic, produces foul odor and putridity in wounds, and is nonpathogenic. The condition of the wound under treatment may become better or worse. If better it heals; the pus is drained and granulation sets in. If the wound becomes worse, the gas gangrene condition rapidly encompasses more area, and we get a condition which demands amputation.

The infection, although primarily caused by anaerobic bacilli, is usually found to contain aerobes, usually streptococcus and staphylococcus. The anaerobes grow better under an environment containing aerobes. Thus to remove the aerobes, which are aiding in causing a media favorable to anaerobes, we inject some staphylococcus vaccine, or a vaccine made from M. tetragenus and streptococcus. The vaccine usually improves the wound. Vaccine gave good results in cases where a condition ensued in which there was a pyrexia, a cessation of the healing process, and an unhealthy appearance in the wounds. In the treatment we must be careful of our use of antiseptic; a very weak solution of chloramine T, for example, will have a stimulating effect upon the organisms.

DISSEMINATION WITHIN THE BODY OF THE HOST

In the case of gas gangrene, the condition is such that dissemination of the infective material to even a comparatively small extent is fatal. The treatment of a wound is determined by the danger of dissemination to a very great extent. If we have the wound in a limb, the limb must be amputated if the infection cannot be controlled. We give our antiseptics with the view of preventing spread of infection. Thus, when a patient is brought into the hospital, the wound is immediately washed with hypochlorite solution, and we apply cusol, Dakin's solution, or chloramine T. Hypochlorite solution is the most effective means for putting an initial stop to dissemination.

Slough-covered wounds are given frequent washings with a 0.5 per cent salt solution, which causes a liberation of a tryptic ferment upon the disintegration of the leucocytes in pus. An exudation of lymph also ensues. I will give a brief summary of a few cases showing dissemination of the disease. (Great Britain Medical Research Council Report **57**: 122-150, 1920.)

I. Bullet entered right thigh, gluteal muscles affected by gas gangrene, no healing, general condition worse—amputation.

II. Gangrene in muscle of leg. Dissemination stopped by hypochlorite applications. Connective tissue repair.

III. Wounded. Was lying on the field for three days before he was picked up. He was very weak from loss of blood, and an infection spread in his leg. He was taken to the base hospital. Wound was treated with Dakin's solution, and every attempt was made to stop spread of infection. Infection continued spreading so that leg was amputated above the knee.

IV. He was wounded in the forearm. Incisions were made for gas gangrene. Infection was counteracted. Granulation tissue repair. Muscle was not as efficient as formerly after wound was healed.

V. Wound in right scapula. Incisions made on surface with extra precautions. Easily repaired. This type of wound offers comparatively little trouble.

VI. Wounded in leg. Muscle became gangrenous and was excised. Rapid recovery followed, although leg was not as efficient as formerly.

VII. Infection in gluteal muscles. Incisions were made into muscle, but did not aid in stopping spread of infection. Muscles excised. Fever followed, and large pieces of necrosed bone were removed from the neighborhood of the sacroiliac joint, which greatly improved the drainage of the deeper portion of the wound. The wound progressed wonderfully quickly, granulations springing up from the bottom and filling the cavity, the epithelium also spreading in from the edges. When later the concentration of material became great and contraction followed, but was not rapid enough, and epithelium stopped spreading, some 45 Steele's grafts taken from the patient's thigh were applied to the granulating surface, no special arrangement being adopted. A second skin grafting operation two months later when the scar tissue was very pronounced, and the granulations in consequence very bloodless, was an almost complete failure. However, under massage to loosen the scar tissue, and to promote circulation, healing progressed slowly and patient was discharged.

VIII. Bullet going through and through, leaves clean wound, very easily healed.

IX. Femur fractured. Drainage incisions made to curb infection. Infection stopped. Operation, binding bone with metallic thread. Operation for removal of metallic thread. Wound heals.

X. Infection attacks to the extent of septicemia, in very weak patient. Death.

XI. Pus from wounds in head drained. This condition is very dangerous due to proximity to the brain.

XII. Repeated amputations. Pleurisy set in. Death due to either septic thrombosis of the vena cava or septic thrombosis of the inferior or common iliac vein.

XIII. Wound healing. Severe secondary hemorrhage, wound opened, but bleeding point could not be found due to infiltration of blood and inflammatory exudation. Amputation found necessary and performed.

In general, we may say this about dissemination. An infection is started and we have an inflammation. Then there is a leucocytic infiltration. Necrosis sets in, muscle and bone tissue are destroyed, there is a lymphocytic infiltration, and a putrefied mass is formed in the wound. The wound has a tendency to close on the surface, leaving a putrid proliferative mass. A flesh wound on the abdomen, if severe enough, may gain entrance into the abdominal cavity. A case of gangrene in the abdominal region is rare, due to the fact that abdominal flesh wounds are easily treated. Dissemination of infection of a wound of this kind into the abdominal cavity is usually fatal.

Thrombosis, embolism, septicemia often result in cases of gas gangrene, the latter being fatal, the former two leading to a critical condition.

Various complications may arise. In gas gangrene septicemia a high temperature is reached (102 to 103 degrees Fahrenheit) and death follows. Very rarely we may get a gas gangrene pyemia. There is an invasion into the blood stream, secondary deposits of gas gangrene bacilli in various parts of the body when the tissues have suffered some slight damage, as from the introduction of a hypodermic injection, or an infusion of saline, or they may develop in tissues subjected to prolonged pressure as in the buttock, when the patient lies in bed tilted on one hip. The prognosis is extremely bad.

CLINICAL SIGNIFICANCE

A. Diagnosis of the Disease From a Clinician's Standpoint

1. *The physical standpoint:* The physical signs differ according to the type of the disease present. A localized anaerobic infection is distinguished by a foul-smelling discharge, mixed with bubbles of gas. If the disease is more extensive, swelling is noted, and upon percussion of the swollen area a tympanitic sound is heard.

By noting the type of wound, we are able to tell whether an anaerobic infection will soon be in evidence. Wounds with imperfect drainage, extensive devitalization, and death of tissue with extravasation of blood, will result in gas gangrene cases. Imperfect drainage is typical in cases where a projectile made a small point of entrance, entered deeply, and was retained. The general condition of the wounded man is also important. Infection develops much more readily in fatigued troops than in fresh troops. An irregular projectile forms a more irregular wound, and may carry bits of clothing, and thus increase the chances of infection. An area with a diminished blood supply precludes active intervention by the protective mechanisms of the body. When a wound becomes infected, it is an anaerobic infection up to the time the muscle is attacked, then it becomes gas gangrene. The muscle becomes black, friable, and diffluent, and the line of invasion is seen. In others we see red and yellow zones or bands. In some our chief symptom is a loss of contractility. The diagnostic features of gas gangrene are pain, crepitation, resonance on percussion, and what is more important, severe constitutional symptoms.

The disease may be one of several types. In the first type we have a localized anaerobic infection. In the second type we have slow spreading. In the third, swelling, and a tympanitic condition and crepitation may be detected. These symptoms become more marked as the disease continues, the skin develops large irregular fibrillae, with blood-stained serous fluid. There is a mottling of purple patches, becoming greenish yellow. The muscle becomes dry, brown, pultaceous, and finally black with a slimy surface. This third type is called the group type. The fourth is the massive type. Here the blood supply is cut off, constitutional symptoms, such as vomiting, rise in temperature, and a rapid pulse are noted. There is a rapid appearance of signs of decomposition. The fifth type is the fulminating type. Severe pain, extensive swelling of the affected part, rapid spread of the disease, and severe constitutional features are the symptoms.

2. *Symptoms:* In the early stages pain is very marked; the unusual amount of pain depends upon the increasing pressure within the wound. When the

infection becomes established, pain increases. There is a feeling of numbness in the superficial parts of the limb. The patient looks distressed and ill. Lips acquire a cyanotic color, the pulse rate is rapid, and the temperature rises 3 to 4 degrees Fahrenheit. There is continuous vomiting. If the disease becomes more rapid, becomes running and uncontrollable, there is more frequent vomiting, the extremities become cold and blue, the temperature falls. The mind, however, remains acute even to the end; in the terminal stages some degree of general icterus may be present. Death comes with dramatic suddenness; the specific cause is still unknown. Pulmonary embolism is never found in autopsy.

B. Laboratory Standpoint

The primary infection is largely made up of fecal material bacteria. B. welchii and associated anaerobes in symbiosis with aerobes, chiefly streptococcus and staphylococcus. After the healing process had begun and granulation tissue formed, no B. welchii were found upon laboratory examination. In recrudescence of bacterial infections after operations, the chief anaerobe to be found was B. sporogenes, always in company with streptococci and staphylococci. As soon as a case was brought into the hospital and physical diagnosis was made, samples of pus were collected and films and cultures were made. The specific organisms causing the infection are thus noted. Weinberg and Sequin give the following figures: B. welchii were found in 72-80 per cent of cases; Vibrion septique in 12 per cent of cases; B. oedematiens in 34 per cent of cases; B. sporogenes in 27 per cent of cases.

REFERENCES

Texts: Hiss-Zinsser, Jordan, Kendall.

Barber, M. A.: J. Exper. Med. **32**: 295-311, 1920.

Great Britain National Health Insurance, Medical Research Council **39**: 1-182, 1919. Committee—Bulloch, Douglas, Henry, McIntosh, O'Brien, Robertson, and Wolf.

Great Britain Medical Research Council Report **57**: 1-122, 1920. Authors—Douglas, Fleming, Colebrook.

NEWER CONCEPTS IN THE TREATMENT OF BURNS*

With Suggestions for the Management of Wartime Thermal Injuries

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IN 1925, when the tannic acid treatment of burns was introduced a remarkable step forward was made in reducing the morbidity and mortality of thermal injuries.

It was soon discovered that tanning (with the later modification of applying silver nitrate to the area) relieved pain by protecting exposed nerve endings and stopped the escape of precious body fluids by forming a damming eschar over the raw area. Both were important factors in reducing shock. However, the method had two marked disadvantages.

In the first place, it was necessary to scrub the patient thoroughly before applying the tannic acid spray, for every effort had to be made to cleanse and "sterilize" the skin before applying, because tannic acid is not bactericidal. Infection and associated toxemia, once started beneath the tough protecting but masking eschar, would often be the cause of the patient's death. This dire complication is usually due to contamination of the raw surfaces before the tanning takes place and the eschar forms. The burned area is sterile for some time after the injury, since bacteria are killed by the same physical cause that kills cells and tissues. Toxemia is the second most important complication as a cause of death from burns; shock is first.

Secondly, when the epithelization occurred under the tough, inflexible eschar, the cells of epithelium that grow into the burned area from the unburned margins were not "normal" in that they, too, had been "tanned." The connective tissue beneath, instead of being elastic, forms tough, contracted bands under the deformed epithelium. This grave aftermath, usually of third-degree burns, frequently causes more concern than the original injury, especially if the face, neck, hands, or flexor surfaces of the extremities are involved. The patient recovers from the burn but is frequently left a deformed, crippled monster. Infection further increases the scarring, even though sulfon-chemotherapy has reduced the morbidity. The patient faces months of painful and expensive plastic surgery in order to return to a semblance of normality.

Not only is tannic acid (even with silver nitrate) nongermicidal, but it has the added disadvantage of being extremely unstable, necessitating fresh solutions whenever needed. Such an eschar is thick and likely to crack, and if the surface to be tanned is already infected, it will not "take."

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It was plainly seen after years of experience with this treatment that for the reasons discussed, the tannic acid method could be improved upon. What other methods could be used to give an antiseptic, analgesic eschar that would provide a dam for escape of tissue fluids, stimulate normal epithelization, and form a nondisfiguring scar?

Aniline dyes had been used in connection with burns for years; singly they did not seem to have the proper qualities to displace tanning.

In 1933 Aldrich[1, 2] happened upon the ideal combination of these dyes. He showed by culturing burns that they were sterile (due to thermal injury of the skin) up to eighteen hours after the injury occurred. If the patient showed no signs of toxemia after this, the wound remained relatively sterile. Up to the seventy-second hour a mixed type of infection could be cultured from the wound surface; and after that period, pure cultures of beta and gamma hemolytic streptococci could be demonstrated in a toxic patient. Aldrich felt that the infection was the cause of this early toxemia, rather than the previously suggested split proteins, and he was able to prove his thesis experimentally, not only by surface culture of the burn, but from blood cultures as well; he also showed that only infected cases became toxic. This led him to search for an eschar-forming dye that was noninjurious to the tissues, yet strongly germicidal. He found that gentian violet was effective against the gram-negative organisms. But it was not until he mixed crystal violet and neutral acriflavine (acriviolet) and brilliant green that he was able to kill the gram-positive organisms as well as the gram-negative, yet not injure tissues. Not only did these dyes in combination (1:1,000 solution) kill all germs; they formed a tough, purple-brown, supple eschar to seal the area, and provided excellent analgesia as well.

If a local area becomes infected in spite of the triple-dye treatment, it is not masked until late in the course of this complication, as it is in the tannic acid method. By daily observation a softened, moist area can readily be detected and by simply trimming it out and respraying the denuded area, one can quickly end this complication.

The three-dye mixture consists of 1 per cent aqueous solution of crystal violet (gentian violet also is used) and brilliant green, and a 0.1 per cent solution of neutral acriflavine. This mixture is quite stable and can be prepared and stored for a long time without losing its efficiency. The crystal violet is specific for gram-positive organisms and has a definite analgesic action in that it coagulates with plasma proteins to form the eschar protection for the exposed nerve endings. The neutral acriflavine and the brilliant green dyes have special germicidal action against gram-negative organisms. In dilution of 1:1,000 the mixture has a phenol coefficient for many of the pyogenic organisms. It is nontoxic to normal tissues, although it stains skin, mucous membrane, and granulation tissue (in fact, everything it comes in contact with) a purple-brown color.

Although dyes are messy to handle, this is insignificant in view of the facts that the morbidity and mortality from burns and the incidence of scar deformity have been markedly reduced with this treatment. Aldrich himself states that he does not "wish to give the impression that by merely spraying

with this dye there will be no mortality. The use of the triple dye makes treatment easier," but other aspects of the treatment, i.e., treatment of the patient, in general, cannot be neglected. He further adds that "it is not the final answer to all problems presented by a burn patient," even though the method is applicable as well to third-degree burns. Contrary to popular opinion, if no infection remains in these carbonized areas, the islands of epithelium that are spared (usually around hair follicles) are enough to grow and spread. Some mild contracture of scar and an occasional infection occurs with this method. "If a new substance is found, it will have all the properties of the triple-dye method and yet be an improvement." In other words, this new substance would have to lessen still further the possibilities of infection and scarring.

This "new substance" was introduced by Pickrell[20] in August, 1941, and is one of the amazing group of sulfon drugs, sulfadiazine (2-sulfanilamidopyrimidine). In this author's introductory series of cases it was found to be much superior to methods previously used for treating burns.

It is a nontoxic, extremely bactericidal, analgesic substance that forms a tough, thin, pliable, and transparent eschar. No contractures resulted in any of Pickrell's cases, even when used around the eyes. It makes the patient so comfortable that 100 of the 115 cases treated were able to leave the hospital on the day of admission and be observed as out-patients. Like the triple dye method, no traumatizing scrubbing of the burned area is necessary. As the eschar is translucent, the granulization and healing can be observed directly; and it is so elastic that motion can be started immediately without cracking or disturbing the eschar in any way. None of the 115 cases developed any infection while the eschar remained in place.

The solution used is one of 3 per cent sulfadiazine in 8 per cent triethanolamine. It has a pH of 8.7; it is clear and has a faint yellow color owing to the oxidation of the sulfadiazine. This, although it does not materially affect the efficacy of the drug, may be prevented by storing it in dark glass bottles. It is odorless, has a bitter taste, and does not stain skin or clothing. It penetrates tissues and can be detected in the blood within several hours after being sprayed on a burned surface. After the eschar forms, the blood level approaches a minimum and remains level. Normal tissue is unaffected by the drug. The triethanolamine is nontoxic, as demonstrated in laboratory animals. If the blood level of sulfadiazine is kept below 15 mg. per cent (20 mg. per cent is the maximum for safety), it can cause no kidney damage. Temporary psychotic episodes and blood dyscrasias are rare with sulfadiazine, although blood counts, urinalyses, and sulfadiazine blood levels, taken at frequent intervals, are necessary to discover such rare eventualities. Other toxic manifestations as drug fever, drug rash, cyanosis, and jaundice seen in the sulfon drugs are extremely infrequent but should be watched for. However, in Pickrell's series only one case showed drug toxicity (kidney damage), even though sulfadiazine was administered orally to some patients as well as being used to treat the burn.

The treatment of burns is divided into two parts: (a) Treatment of shock (primary, secondary, or tertiary). (b) Treatment of the burn itself.

Treatment of shock should be undertaken *at once*. The most critical period for a burn case is eight to twelve hours after the injury has occurred. If the

patient has had a relatively severe burn and is not in shock, treat him as if he were. The treatment of the burn should not be begun until the shock therapy is well under way and the patient has a normal temperature, relatively normal blood pressure, a good pulse and respiratory rate, and his skin is warm and dry. Continue shock therapy while treating the burn. Wrap the patient in sterile sheets to protect the burn and *treat the shock*.

Primary shock is that stage that comes on immediately after the injury and is similar in every respect to surgical and traumatic shock. The contributory causes are: (a) The general withdrawal of blood plasma into the tissues and loss of plasma from the burned surfaces. (b) Severe pain from the exposed nerve endings.

Plenty of morphine should be given. Grain ⅓ to ½ can be administered with impunity and repeated every four hours, or as often as necessary to keep the patient comfortable. Pain itself is an excellent antidote for an overdose of this narcotic. So keep the patient free from pain.

Apply external heat in the form of heated blankets or a heat cradle. Hot-water bottles, electric pads, or anything available should be used to keep the patient warm.

Elman,[8] Black,[4] and others have definitely shown that the volume of blood during this stage is depleted by loss of plasma through the capillaries and larger vessels, and from the burned surfaces.

The administration of plasma at this time is to be strongly advised. If possible, plasma should be given to *all* severe burn cases. If this is not available, whole blood may be used, although this adds erythrocytes to an already too viscous blood. Parenteral fluids are contraindicated, for they further dilute the blood proteins and only temporarily stay in the peripheral circulation.

Rhoads[22] and his co-workers, Ivory,[16] and others, have shown that the use of adrenal cortical extract (eschatin, cortin) decreases capillary permeability and helps maintain the plasma level in the blood, thus reducing the incidence of secondary shock in severe burns.

Stimulants, such as ephedrine sulfate (grain ⅜), adrenaline (minims v-x), or other pressor substances; caffeine sodium benzoate (grains 7.5), strychnine sulfate (grain 1/30), coramine (1 c.c.), metrazol (1 c.c.), may be administered parenterally if indicated. However, the above treatment should make their use unnecessary, except as a heroic measure.

The patient's head should be kept low (Trendelenburg position) to increase and maintain cerebral circulation. Due to the anoxia as a result of diminished blood volume and poor peripheral circulation, as evidenced by the high blood viscosity and low arterial blood pressure, it is recommended that oxygen be administered throughout the entire shock therapy by means of a Boothby mask. Poor oxygenation of the tissues is the prime factor in causing parenchymatous damage.

Secondary shock occurs from ten to twenty hours after the injury, but it may be delayed as much as two or three days, and is the so-called histamine shock of Cannon (absorption of tissue breakdown substances). The author believes it is merely a more extreme form of primary shock and should not occur if the patient is properly treated. It is due to increased hemoconcentration and can be treated with plasma transfusion and prevented by the use of

adrenal cortical hormone. During this stage the viscosity of the blood, which normally is 2.4 (taking water as 1.0), increases to 4.0 and 5.0.

Third type of shock is relatively uncommon and, if present, makes the prognosis very grave indeed. It is a prolongation of the second phase, with a blood viscosity so great (6.0 to 7.0) that the patient's own cells act as thrombi and emboli to cause cerebral, liver, and kidney damage (anoxia). This stage of shock is hard to treat, for fluids injected into the venous side of the circulation cannot be pumped out to thin the capillary blood. Prevention is the best treatment for this stage. Administration of plasma via the sternal marrow is the treatment of choice in this stage of shock (Tochantin).

Burns are classified as first degree (stage or erythema), second degree (erythema plus bullae formation), and third degree (stage of carbonization; erythema with bullae are also present).

In discussing the treatment of the burn itself, the general details will be taken up before going into the specific methods for the triple dye and the sulfadiazine-triethanolamine techniques.

In general, the following procedures are followed in the order in which they appear:

(a) Wrap the patient in sterile sheets and proceed to the operating room.

(b) Treat the shock; do not proceed until you feel reasonably assured that the patient is out of shock, and is being treated for shock during the burn treatment (see above).

(c) Don mask and cap. All observers, assistants, and nurses do the same. Remember outside contamination (especially droplet contamination from the noses and throats of spectators, etc.) causes infection of burns.

(d) Scrub in the usual manner; don gown and gloves (all assistants do the same).

(e) The burned areas are gently and carefully débrided of all dead tissues and bullae. The area is not cleansed or scrubbed in any way unless to remove, gently, previously applied grease or oil. Antiseptics are not applied to traumatize further the tissues.

(f) The dye or sulfadiazine solution is sprayed on the débrided area with an atomizer, as outlined below.

(g) If delayed blisters appear twenty-four to seventy-two hours or more later, the above procedure is repeated.

The triple-dye method is as follows:

(a) Follow the foregoing outline in preparing the patient. *Treat shock!*

(b) The dye solution (1 per cent aqueous solution of crystal violet and brilliant green and 0.1 per cent solution of neutral acriflavine) is sprayed on the burned areas every hour for eight hours. An eschar forms at the end of the first or second spraying, but is not complete until the end of eight hours.

(c) Keep a heat cradle (not over 90°) over the patient.

(d) Observe the eschar daily for soft, moist spots.

(e) Excise soft, moist (infected) areas, gently sop up secretions with a sterile sponge, then respray as above.

(f) Continue daily observations until epithelization is complete or the granulation tissue is built up enough to take a graft.

(g) In case of massive infections (seen where burns occur around body orifices and are continuously being contaminated), the eschar may be removed and the raw surface treated with saline spreads until clean and then resprayed.

(h) No dressings of any kind are applied.

(i) The eschar comes off in about one to three weeks with the surface beneath more or less normal skin. Rarely and only where the burn is third degree is a skin graft needed.

The sulfadiazine-triethanolamine method is as follows:

(a) Follow the same general outline for preparing the patient (see above). *Treat shock!*

(b) Spray the burned area with the solution every hour for the first twenty-four hours. A heat cradle at 90° should be used.

(c) Spray every two hours the second day.

(d) Spray every three hours the third day.

(e) Spray every four hours the fourth day. By this time a thin translucent eschar has formed that is soft and pliable.

(f) Encourage active motion; if the burn is not too extensive, allow the patient up and about. If the burn is less than 20 per cent of the body surface, discharge from the hospital. Motion prevents contractures.

(g) In about ten days the eschar begins to loosen from the epithelium beneath. Applications of the mixture or saline compresses speed the separation. In third-degree burns, allow the eschar to remain in place for three weeks. This type may need grafting. This is done after saline spreads have been applied for several days. Observing the burn through the translucent eschar makes the rare infection easy to detect. If present, soak off the eschar and respray.

(h) Ambulatory patients, i.e., those treated and sent home within twenty-four to forty-eight hours, are sprayed frequently during their stay in the hospital, and the burns are covered with sterile vaseline gauze or an ointment made up of 5 per cent sulfadiazine and 8 per cent triethanolamine. In these cases no eschar forms, so they are seen every twenty-four to forty-eight hours and the burns are resprayed and redressed with the vaseline gauze or the ointment. This is repeated until the burn has healed.

During wartime the treatment of burns presents several added problems. First, they are usually complicated with other injuries, such as fractures and soft tissue wounds. Secondly, the problem of sepsis is a greater one, because of the great amount of contamination and the inability to give the wounds and burns the immediate care needed to prevent infection. Koch believes that a wound or burn is contaminated and, therefore, potentially septic two hours after injury, provided no treatment is given the patient in that time. In the author's experience, six to eight hours are the upper limits. However, since the advent of the sulfon drugs and the "plaster-cast-let-alone" treatment, the latter being revived during the Spanish Civil War, it is possible to treat even these potentially infected wounds as "clean." Since the introduction of the sulfadiazine-triethanolamine treatment, this problem should be further simplified.

The spore-forming organisms are all too frequent contaminants of wounds in wartime; the administration of prophylactic doses of combined tetanus gas bacillus antitoxin is obligatory. Then again, as the eschar seals the burn from the outside air, a treated burn is an excellent place for the growth of these anaerobic organisms. In civilian practice some surgeons routinely give at least the tetanus antitoxin (3,000 units) to all their burn cases.

In reviewing the literature extant on the treatment of burns since the start of the present war, it is readily seen that no standardization of treatment has been devised. It is the author's impression that the greatest difficulty with this problem lies in the failure to set up a definite standard simple plan for first-aid and hospital treatment based on one or the other of the specific methods described in this paper. There are too many diversified forms of treatment, depending on the type of burn, its location, whether or not it is complicated by a wound, etc. There can be only one method for routine, standard treatment.

All the British authorities have agreed upon the necessity of treating the shock. They have reduced the mortality tremendously by using heat cradles, plenty of morphine, routine administration of adrenal cortical extract (2 c.c. per dose) in liberal amounts, and, best of all, the use of plasma. Primary shock from burns is not seen often in wartime Britain, but 80 per cent of deaths from this injury are due to secondary shock.

If the patient has a hemoglobin of over 100, it is obligatory to give him plasma and keep giving it until the hemoglobin readings reach more normal figures. Pseudopolycythemia is a good index to the increased viscosity of the blood—and taking a hemoglobin and/or red blood count are easy, quick ways of determining the concentration of blood.

In severely wounded cases British surgeons find it advisable to administer oxygen routinely by means of the K. L. B. mask (Boothby type). The Royal Navy, which has had this type of mask available for use, has found it invaluable in saving lives, especially in cases that are complicated by "blast lung."

Hot coffee (6 ounces) by rectum or by mouth has been a successful adjunct in treating the shock cases. It is an excellent stimulant and helps keep the patient warm. The latter factor is stressed, and a large percentage of injured men that were successfully kept warm at Dunkirk, lived, in spite of the lack of much else in the way of treatment. Any means available was used. Immersion in the sea seemed to help preserve body heat, for none of the burn cases rescued from the Channel were in shock.

As for the first-aid treatment there are as many methods as there are medical officers in the British Army and Navy. Tannic acid jelly seems to be the most generally used, since all tanks, gun turrets, etc., are equipped with tubes of this material. However, gentian violet, picric acid, acriflavine, paraffin, gentian violet and merthiolate, amertan jelly, tannafax, and tannax all have their advocates.

The tannic acid jelly is the favorite for first-aid applications; and when a burn case is first seen, the routine consists of plenty of morphine, keeping the patient warm, liberally spreading tannic acid jelly upon the undisturbed burn (no first-aid station débridement), and applying two or three layers of gauze over it and holding them in place by a bandage. This is left *in situ* until the patient reaches the hospital. Of course, his other wounds are treated, splints are applied, etc., at same time the burn receives attention, placing the jelly into wound surfaces if necessary.

The patients mentioned above who were immersed in sea water for long periods had a very low incidence of infection. Wakeley[24] favors the use of gentian violet in first-aid treatment over the tannic acid jelly because of its greater germicidal action, and for this reason even places this material into compound fractures.

After the patient gets to the hospital, he is assigned to a special ward for burn cases and taken to a special operating room. Due to the high incidence of crossed infections, burns are treated and bedded in "clean" operating rooms and wards.

If much dirt, grease, fuel oil, and dead tissue are present after the shock has been treated, the burn is cleansed and débrided under aseptic conditions,

the patient being anesthetized with either intravenous pentothal sodium or evipal (evipan). No untoward effects were encountered from these anesthetics. Little gas oxygen anesthesia is used and chloroform and ether are never employed.

The débridement consists of first shaving the hair and removing the fingernails and toenails, if necessary, around the injured parts which are then gently cleansed with ether soap. Cotton pledgets and soft friction are used. The wound is then rinsed; or if deep, irrigated with saline solution. The burned area is then dried with a hair drier.

The triple-dye method is used rather extensively in most British military hospitals. The incidence of infection and toxemia has been dramatically reduced by this method. The tannic acid-silver nitrate method is still used. However, where deformity is feared (i.e., in burns of the neck, face, flexor surfaces, or the hands), this treatment is avoided. The eschar of the triple-dye method, when used on the localities mentioned, is removed as soon as granulation tissue is favorable for skin grafting. This prevents deformity. Wakeley[24] uses a combined aniline dye (gentian violet) tannic acid treatment. He applies the dye first for its germicidal effect and then tans the area by the usual method.

Splints and casts are used by many surgeons to put the part to rest, but are not applied until all swelling has subsided. Heat cradles are kept over the patient at all times. Limbs are elevated to promote venous drainage and keep down swelling.

Saline immersion baths are used by some men for treating burns, especially third-degree burns and burns of the hands and flexor surfaces. Saline packs are used upon the face. This method also helps separate the eschar.

Mathews[18] uses the "tulle gras" method of treatment. This dressing is made up of close-mesh gauze and is cut into suitable squares, impregnated with soft paraffin (98 parts), balsam of Peru (1 part), and olive oil (1 part). These squares are packed in a covered metal container, each separated by white paper to facilitate removal, then the above paraffin mixture (250 Gm. for a container 5 inches square and 2 inches deep) is poured into the tray and is sterilized for an hour at 150° and the container is sealed. A local anesthetic (1 per cent decicain or 0.1 per cent percaine) may be added. This is applied to all raw surfaces and left *in situ* as long as the paraffin base lasts, and should be removed by saline immersions of the part. Some authors have used this method on hand and face burns. Gauze dressings saturated in saline are placed over the "tulle gras."

Cod-liver oil and cod-liver oil ointments are rather extensively used in Britain, especially for burns of the face and hands. German army doctors have been using this method; they use tannic acid for other burns.

Bunyan uses the "bag method" in treating his hospitalized burn cases. This consists of primary irrigation and cleansing with 10 per cent electrolytic hypochlorite solution at 100° with the patient under an anesthetic. Coated silk watertight envelopes are then placed on the limb over the burned area. No other covering is used. The envelope is so rigged and is sealed at each end that hypochlorite solution can be run through it, irrigating the wound. This is done two or three times daily.

Hudson[15] modified this method of Bunyan's by using impregnated silk as an occlusive dressing (where the bag cannot be used). If a large area of the

body is burned, he uses a large envelope that includes the entire body, then applies irrigations of hypochlorite. He also advocates the use of sulfathiazole cream in infected burns.

Extensive and third-degree burns are also treated by a large number of men by the saline-immersion method, 0.9 per cent saline at body temperature, which is thermostatically controlled. Some apply "tulle gras" after the immersions until grafting can be done.

Gas warfare has not been used to any great extent during the present war, and it is beyond the scope of the paper to discuss in detail the treatment of such burns. However, after specific decontamination, they are treated by the usual methods.

Chemotherapy is extensively used as an adjunct in treating burns. Sulfanilamide seems to be the drug of choice. Sulfapyridine is used only if pneumonia complicates the picture (this is not infrequent in severe burns), because of its "toxic reactions," such as nausea, vomiting, etc. Sulfathiazole is prescribed as well as the sulfanilamide, but not as extensively. Sulfadiazine was not mentioned by any of the authors. Powdered sulfon drugs are not used on burns, although they are put into wounds. As previously stated, Hudson[15] uses a sulfathiazole cream and Robson[23] uses a glycerin sulfonamide paste ("euglamide") in infected burns.

Plaster casts are used in deep burns or where the burns are complicated by other injuries. Casts are not applied until edema subsides. Then the limb is wrapped in sterile sheet-wadding and the part is encased in plaster in the position of function. They are not removed until healing has taken place, even though they become foul-smelling. This is the lesson learned from the recent Spanish Civil War. Apparently a bacteriophage is formed that inhibits bacterial growth in the patient's infected tissues, finally eliminating the infection. Little or nothing is mentioned, in any of the papers reviewed, about the routine administration of tetanus or gas bacillus antitoxins, nor is the incidence of these complications discussed.

In conclusion, the author can only urge that a definite, simple standard routine treatment for burns be adopted by the United States armed forces. In his estimation the sulfadiazine-triethanolamine solution is the treatment of choice. As was indicated, it can be used as an ointment in first aid and as a solution in the hospital treatment; it is stable, nontoxic, nonstaining, and highly bactericidal. The drugs can be placed into soft tissues and compound fractures or other wounds so that complicated burns need not have separate forms of treatment. It can be safely used on the face, neck, hands, and extensor surfaces with little fear of contractile scar deformity, even in third-degree burns. In short, it has all the advantages and none of the disadvantages of all the other types of treatment.

The standard routine treatment suggested is as follows:

FIRST-AID TREATMENT

(a) *Keep patient warm* by any means possible; blankets, coats, hot coffee, hot water bottles, etc. Place the patient out of the weather.

(b) *Relieve pain* by giving adequate doses of morphine, grain ⅓ to ½, every half hour if necessary.

(c) *Prevent loss of plasma* and plasma proteins by administering adequate amounts of adrenal cortical hormone (2 c.c. dose) parenterally. Plasma infusions should be started.

(d) *Apply sulfadiazine (5 per cent)—triethanolamine (8 per cent)—stearin ointment* ("lubricating jelly" should be used as a base to make a water-soluble ointment) to the otherwise undisturbed burned areas. No débridement is done. Apply a sterile dressing to protect the burned area.

NOTE.—In the alternate method the triple-dye ointment made up of an aqueous solution of 2 per cent crystal violet and brilliant green and a 0.2 per cent acriflavine in a "lubricating jelly" base should be used for the first-aid treatment instead of the sulfadiazine-triethanolamine ointment.

(e) *Remove the patient to a hospital* as soon as possible.

HOSPITAL TREATMENT

(a) Wrap the patient in a sterile sheet.

(b) Begin antishock therapy.

1. Place the patient in Trendelenburg position.
2. Apply heat cradle (90°).
3. Plasma should be given; adrenal cortical extract should be routine.
4. Give more morphine if indicated.
5. Oxygen should be routinely administered by means of a Boothby mask.

(c) Give the tetanus-gas bacillus antitoxin. (Is the patient sensitive to horse serum?)

(d) Operator and assistants prepare themselves for a sterile operation.

(e) The patient is draped.

(f) If burn and other injuries are extensive and dirty, requiring cleansing as well as débridement or other surgical procedures, intravenous sodium pentothal should be administered.

(g) Débridement and *careful, gentle* cleansing is performed. Wash and irrigate with sterile saline. Dry with hair dryer.

(h) A solution of 3 per cent sulfadiazine and 8 per cent triethanolamine is sprayed on the burns.

(i) The patient is placed in bed. Shock therapy is continued (plasma and cortate are administered) until blood shows normal viscosity. (Check hemoglobin and red blood cells.) A heat cradle is kept over the patient. *Be careful;* shock may be delayed up to ten and twenty hours after the initial burn.

(j) The burn is sprayed hourly the first day; every two hours the second day; every three hours the third day; and every four hours the fourth day. By this time the eschar is complete.

NOTE: If the sulfadiazine-triethanolamine solution is not available then the triple-dye aqueous solution (1 per cent crystal violet and brilliant green and 0.1 per cent acriflavine) should be used to spray the burn. The spraying is done every hour for eight hours.

(k) Check blood and urine daily for sulfadiazine levels and crystals, respectively. Do not allow the former to go above 15 mg. per cent.

(l) Observe the eschar daily. It is translucent and the tissues beneath are in clear view. If the burned surface beneath appears infected, remove the eschar with saline soaks, apply sterile saline spreads for a few days and then respray.

(m) When the eschar begins to loosen (about tenth day), warm saline immersions can be used to help loosen it. Do not remove a third-degree burn eschar under two weeks. It is best to leave it in situ for three weeks.

(n) Encourage motion. Get the patient up and about as soon as possible; on the day of admission, if feasible. The soft eschar does not interfere with motion.

(o) If large denuded areas of granulation tissue remain after the eschar falls off, apply saline spreads for a few days and perform skin graft as soon as possible to prevent disfiguring scars.

The triple-dye method can be substituted for the sulfadiazine-triethanolamine ointment and solution. It is almost as efficient, but is messy and has more tendency to cause disfiguring scars, although these are not as severe as in the tannic acid treatment. The dye method has an advantage in that it is more economical. Sulfadiazine is still a rather expensive drug; however, the added cost is justified by the lowered incidence of morbidity, mortality, and deformities. The tannic acid treatment for burns should be discarded, for with the newer treatments this method has outlasted its usefulness.

BIBLIOGRAPHY

1. Aldrich, Robert H.: Treatment of Burns With a Compound of Aniline Dyes, New England J. Med. **217**: 911, 1937.
2. Aldrich, Robert H.: Treatment of Burns With a Compound of Aniline Dyes, Maine M. J. **28**: 5, 1937.
3. Allen, Harvey S.: Treatment of Superficial Injuries and Burns of Hand, J. A. M. A. **116**: 1370, 1941.
4. Black, D. A. K.: Treatment of Burn Shock With Plasma and Serum, Brit. M. J. 2: 693, 1940.
5. Bunyan, John: Treatment of Burns and Wounds by the Envelope Method, Brit. M. J. 2: 1, 1941.
6. Cohen, S. M.: Experience in Treatment of War Burns, Brit. M. J. 2: 251, 1940.
7. Devine, J. B.: The Three-Dye Treatment of Burns, M. J. Australia **1**: 924, 1939.
8. Elman, Robert: The Therapeutic Significance of Plasma Protein Replacement in Severe Burns, J. A. M. A. **116**: 213, 1941.
9. Flemming, Cecil: Combination of Burns and Wounds, Proc. Roy. Soc. Med. **34**: 53, 1940.
10. Florcken, H.: The Treatment of War Burns, Chirurg. **12**: 89, 1940.
11. Glover, Donald M., and Sydow, Arnold F.: Fifteen Years of the Tannic Acid Method of Burn Treatment, Am. J. Surg. **51**: 601, 1941.
12. Grower, Walter A.: Treatment of Fresh Burns With Scarlet Red Bandage and Moist Sulfanilamide Dressings, J. Iowa M. Soc. **31**: 234, 1941.
13. Grigsby, B. C.: Sulfanilamide in Burns, Virginia M. Monthly **67**: 306, 1940.
14. Hardin, Parker C.: Cod-Liver Oil Therapy of Wounds and Burns, South. Surgeon **10**: 301, 1941.
15. Hudson, R. V.: Wounds and Burns Treated by Coated Silk Fabric, Brit. M. J. 2: 7, 1941.
16. Ivory, Harry S.: Use of Cortical Adrenal Extract in Treatment of Severe Burns, Mil. Surgeon **87**: 423, 1940.
17. McClure, Robert D., and Lam, Conrad R.: Problems in the Treatment of Burns; Liver Necrosis as Lethal Factor, South. Surgeon **9**: 223, 1940.
18. Mathews, D. N.: Dressing Open Wounds and Burns With Tulle Gras, Lancet 1: 43, 1941.
19. Murless, B. C.: Treatment of Infected Burns, Brit. M. J. **1**: 51, 1940.
20. Pickrell, K. L.: A New Treatment for Burns, Bull. Johns Hopkins Hosp. **69**: 217, 1941.
21. Pierce, Wilmot F.: Use of Sulfhydryl Solution in Treatment of Burns, Preliminary Report, Am. J. Surg. **53**: 434, 1941.
22. Rhoads, J. E., Wolff, W. A., and Lee, W. E.: The Use of Adrenal Cortical Extract in Treatment of Traumatic Shock of Burns, Ann. Surg. **113**: 955, 1941.
23. Robson, J. M., and Wallace, A. B.: Use of Glycerin-Sulfanilamide Paste in Treatment of Burns, Brit. M. J. **1**: 469, 1941.
24. Wakeley, C. P. G.: War Burns and Their Treatment, Practitioner **146**: 27, 1941.
25. Wakeley, C. P. G.: The Treatment of War Burns, Surgery **10**: 207, 1941.

MILITARY DISCIPLINE*

A Problem in Readjustment

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SINCE the birth of our nation it has been necessary to expand rapidly our military forces to meet the major military conflicts in which our country finds itself involved. Once again we are faced with the problem of raising a large military force, consistent with military efficiency and the urgency of the situation, in as short a time as possible.

In this swift expansion many persons must make a rapid readjustment; their being uprooted from civil life and placed in a military environment may, in many cases, result in neuropsychiatric difficulties. This change may alter not only a person's hopes for the future but also his manner of living substantially. Two changes are especially difficult for him: first, the loss of his individuality; and, second, the loss of personal liberty. He soon comes to feel that he is a cog in a vast machine, required to give up certain rights and privileges which he has enjoyed and to which he feels entitled. He is subjected to military discipline, and is placed among strangers. It is easily understandable that a great strain is put on his power of adjustment. He finds that more demands are made of him, more responsibility is placed on him. He is compelled to undergo certain hardships, such as participating in maneuvers, and when a state of war exists, he is faced with the possibility of death or injury.

All these new adaptations are, from their very nature, difficult for the normal man, to say nothing of the unstable one. It is obvious, then, that many men will fail completely when these new adjustments are thrown upon them, and a frank psychosis will result. Many conflicts present themselves in the nature of behavior problems and a breech of discipline, which sooner or later brings the man into conflict with military law. It is the purpose of this paper to discuss the important angle of military discipline, to explain its purpose, and thereby to help the person to effect a more healthy readjustment from civil to military life.

The subject of military discipline is little understood outside the Army and, it must be confessed, is not always viewed in its proper light even within the Army. The difficulty may lie in the fact that most people either do not, or will not, grasp the proper meaning of military discipline, its nature, its purpose, its necessity, and finally, most important of all, its spirit.

Living within an atmosphere of strict discipline from the cradle to the grave, most persons fail to realize this because only a gradual adjustment is necessary. Practically every experience through which we pass and through

*From the Neuropsychiatry Division, Office of the Surgeon General.

which we acquire knowledge is in the nature of a disciplinary correction inflicted upon us by some agency of nature or of civilization.

Outside of military circles the average man recognizes fully the necessity of discipline in his family relationships, his business, and his relations with his fellow men. This is made easy for him to understand, since he is familiar with the reasons and conditions that surround the rearing of a family and that must necessarily govern the relations of men in civilized intercourse. All this information is gathered gradually by the average man, and there is no necessity to familiarize himself with it or to make a readjustment to it rapidly.

On the other hand, the average man is not familiar with conditions in the military service or, if he has some information, it is, no doubt, based on false information and is colored by fancy or rumor. Ignorance of a situation always provokes a reaction of fear, and when a person has knowledge of a situation he tends to lose at least some of the fear. It follows then that when the man does not understand the reasons for the rules and regulations required by military discipline, he is more than likely to view them with fear and intolerance. Even within military circles, among men who should be familiar with the reason and spirit of military regulations and discipline, many make the serious mistake of confusing the exercise of authority with the maintenance of discipline. In brief, they appear to think that discipline must be maintained wholly for the purpose of upholding their authority; and again, both outside and inside military circles, many fail to understand the spirit upon which true military discipline is based and must be based. Failing in this, they fail altogether, for the simple reason that men can understand the principle of military discipline only when they appreciate the underlying spirit.

Without the proper spirit there can be no such thing as discipline in any army. Proper discipline should, in no sense, be based upon the fear of disciplinary correction, since in this instance we have merely the blind obedience of the schoolroom type of discipline. The discipline on which a successful army must be built is a different kind; a kind that endures even when every semblance of authority has vanished, when the leader of the team has fallen, when members of the team are dropping out one by one, and when the only driving power that remains is a strong and unconquerable spirit of attainment. This concept gives us at once a working definition of military discipline: the spirit of the team.

Oftentimes the question is asked, "Of what necessity is military discipline?" The answer is readily found in the necessity for teamwork in any understaking, irrespective of whether it be in business, on the baseball or football field, or in the training of a vast army.

One element of good discipline is the fear of losing the respect of one's fellow members of the team, whether he be officer or soldier. This desire for esteem is one of the essentials of good military discipline. It is to be seen in all trained and disciplined units, the members of which feel for each other a natural respect and admiration. The knowledge that he enjoys the respect and admiration of his fellow soldiers is a source of the greatest pride to each member of the unit. The desire to retain this respect, to be looked upon as a worthy member of the unit, will greatly lessen the fear of injury.

In our present emergency we are attempting to inculcate in the minds of our soldiers the necessity of protecting our country, of taking the offense, and of bringing the war to a successful conclusion as rapidly as possible. Ideals have been set up, and the soldier must be helped to realize that he is fighting for a cause. He must be aided in finding satisfaction in serving such a cause and in expending his energy for that cause. It is needless to point out that Pearl Harbor and the subsequent events have given us the cause. The soldier must be physically developed, trained to conserve health, and he must learn to perform with technical skill his part in every incident as a member of the great team of which he is a member.

Besides these qualifications he must have the mental attitude of a soldier. To attain this proper attitude is an important step; there is an ideal characterized by the tendency to correct action and supreme satisfaction in such action.

In a short treatise Pew* places considerable stress upon the process of acquiring proper military habits and gives four maxims:

1. Select the habit.
2. Demonstrate the habit.
3. Secure abundant and genuine practice, with every effort of will and attention directed toward acquiring the habit.
4. Allow no exceptions.

Under this grouping this author classifies military bearing, courtesy, putting forth physical and mental efforts at the highest possible level, mental and physical self-control, neatness and order, smartness, exactness, and promptness; subconscious obedience, mental alertness, and confidence; and last but not least, teamwork in all military efforts. The old maxim "A chain is as strong as its weakest link" applies more than ever to the military forces of this era. Likewise, the same maxim applies individually to both officers and enlisted men.

It is held by many civilians and civilian agencies that military discipline would be desirable for those men who have failed to make a satisfactory adjustment to civilian life. It is to be pointed out that the Army is one of the elements of national defense, and its present mission is one of preparation for offensive and defensive warfare. To forge into that great team links that are defective or weak is to invite disaster. The Army is in no sense a social service or a curative agency. It should not be considered a haven of rest for the wanderer or shiftless, or a corrective school for the misfits, the ne'er-do-wells, or the chronic offender. Furthermore, it is neither a gymnasium for the training and development of the undernourished or underdeveloped, nor is it a psychiatric clinic for the proper adjustment of adults who are in need of emotional development and guidance. The man entering the Army will have to assume one of the greatest of obligations: that of protecting his country and its ideals. Therefore, there is no place in the Army for the physical or mental weakling, the potential or present behavior problem. If a man is a behavior problem in the community, he will certainly become a more intensified one in the Army.

It is to be further stressed that many men with abnormal personality traits are capable of satisfactory adjustment in civilian life. For this class there

*Pew, W. A., Maj. Gen., M. N. G.: *Making a Soldier,* 1917.

are in civilian life numerous avenues of escape which are closed to them when they enter the great team of the Army. Necessarily, teamwork of any type, more especially the Army, requires that a man readjust himself to a more or less inflexible and limited environment. When thrown upon their own meager resources of adaptation to Army life, requiring contact with all types of personalities, with limited and necessarily circumscribed opportunities for self-expression, many who are just able to adapt themselves under the most favorable conditions will not fit into that one iron mold which experience has taught is essential to military success. It is well to point out that over 50 per cent of the present beneficiaries of the Veterans' Administration are men of this type who were accepted in the Army during World War I.

The average selectee coming from the average American home has received the care, protection, and indulgence of fond parents and friends. They have made an effort to protect him from disturbing and disrupting influences that might interfere with his normal development. His parents have been interested to see that he wore the proper clothing and had the protection for all types of weather. New problems were taken over by his protectors who either solved them for him or helped and advised him in his own solutions. He has been guarded, protected, and steered, while his personal responsibilities have been at a minimum. He has not been trained to accept life as it really is.

Our soldiers come from all walks of life—from distant points in our country, from farm and factory, from colleges and benches; the rich and the poor, the educated and the illiterate—all are thrown together into a heterogeneous mixture subjected to the same military discipline, the same routine, and the same regulations. The soldier is called upon to recognize, appreciate, and conform to the wishes of others about him. He must live in close contact with his fellow soldiers and adjust himself to their method of living.

The transition from civil to military life will be made much easier for him if he understands the necessity for military discipline, the spirit of the team, and the real meaning of it. Americans are well adapted by their education and recreational experiences to realize the importance of teamwork, but sometimes it is necessary to point out to them that military discipline is a preparation and is necessary for the development of good teamwork.

It is astonishing how well and how rapidly recruits adapt themselves, even under the most difficult situations. It is the duty of each officer to keep these situations in the foreground and to take every opportunity to advise and counsel the men placed under him for proper training in military life. Each officer should regard himself as a member of a team in which each of his soldiers is an important member. Thus is built up a chain forged of confidence and respect one for the other, which will provide a pillar of mutual strength, both mentally and physically, when times of stress are greatly increased. It is, then, through military discipline that a strong, efficient team with high morale can be developed that will satisfactorily achieve the goal set for it. By understanding the reason for it, the man is enabled to make the transition from civil to military life in a more satisfactory manner.

WAR NEUROSES*

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INTRODUCTION

THE subject of war neuroses met with little interest and came in for little discussion until the World War. The subject became a vital one and has continued to demand attention ever since. It was during the war that for the first time such large numbers of individuals suffering from nervous disorders confronted the public, physicians, and government agencies. Psychiatry, a field of medicine which to a great extent was practiced in crowded institutions behind locked doors, was forced into the open and into its lap was thrust a problem which it has not yet fully solved. And now again it is to be given a task that will keep it occupied for many years to come. It is, therefore, important that physicians in the armed services and others who have occasion to deal with the psychiatric patient of preparedness and of war be familiar with the present-day concept of war neuroses.

DEFINITION AND MECHANISMS: IMPORTANCE OF PREDISPOSITION

Since war now embraces civilian as well as armed forces, the term will now necessarily be applied to both groups. Under war neuroses have been included a great many varieties of conditions. The diagnosis of exhaustion neurosis, shell shock, concussion neurosis, fright neurosis, and neurocirculatory asthenia have been applied to the manifestations which were so prevalent in soldiers during the World War. The symptoms were varied and consisted of tremors, inability to stand or walk, blindness, paralysis, stammering, and loss of voice. Many soldiers suffered from nightly frightening dreams and awakened with intense anxiety. Others complained of marked weakness with fatigue brought on by the slightest exertion, palpitation of the heart, or of dizziness or faintness, headache, or pains referable to practically every part of the body.[1]

The occurrence of such large numbers of these cases suggested a specific relationship between these conditions and war, and led to the naming of these conditions war neuroses. Referring to the World War, one authority stated that it is noteworthy that since the war and in the decade or two before it, such gross hysterical phenomena were only rarely met with in civil practice.[1]

However, it was observed that many soldiers developed the symptoms after slight or no injury during combat, behind the lines, in concentration camps away from the front, and in training camps at home. Also, the war neuroses differed little in their symptomatology from those of civil practice.[1]

The London correspondent of the *Journal of the American Medical Association* wrote the following in February, 1940:[2] "During the last war, the

*From the Neuropsychiatric Section, Station Hospital, Fort Bragg, North Carolina.
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large number of neuroses engendered by fear, shock, physical and mental strain or lack of sleep caught the medical officers of the army unprepared with any organization or agreed method of treatment. These neuroses were popularly called 'shell shock,' for it was supposed that they were due to the physical effects of high explosives. But it was found that similar symptoms occurred among men who had never been exposed to explosives and were well known in civil life. Moreover, many men who were blown up or buried beneath debris to the same extent returned to duty without suffering any permanent ill effects. The minister of pensions convened a conference under the chairmanship of Lord Horder to advise the government as to the general principles for dealing with these cases. Its report has just been presented and issued to the medical services." The report points out that most of the neuroses took the form of either an anxiety state or hysteria. The anxiety in all the cases was far out of proportion to the cause.

"In 1920 the army council appointed a committee to collate the medical experience of the war for future use. The committee reported: 1. The term 'shell shock' has been a gross and costly misnomer and should be eliminated. It is a catchword which reacts unfavorably on the patient and others. 2. The war produced no new nervous disorders. Only 5 to 10% of the cases that were called shell shock suffered from genuine concussion—while 80% consisted of 'emotional shock'—either acute in men with neuropathic disposition—or developing slowly as a result of prolonged strain and terrifying experience, the final breakdown being sometimes due to some trivial cause. In differentiating cases of concussion from those with emotional shock, it is well to remember that though patients with emotional shock may say that they became unconscious, careful questioning will show that they can recall most of their experiences."

Many cases now in training in Army camps are entering hospitals with nervous disorders. During wartime these cases might be called shell shock, if they started during a bombardment and were seen by physicians who were not familiar with the true nature of the condition.

In a vast majority of cases of neuroses that are being admitted to the hospital at Fort Bragg, a history of long-standing nervousness can be obtained. Many of these individuals frankly admit that they are no worse for being in the Army—that they "have always been that way." No statistics are available at present, but it is rare to find an individual whose nervous trouble began after enlistment or induction into the Army.

If the reaction, then, is not specific for war, it becomes necessary to explain the appearance of such large numbers of cases. It is important to consider first the question of predisposition to neurotic disorders. Individuals vary markedly in their abilities to tolerate difficult situations, as they do in adjusting to new situations. Some always worry while others are not fazed by the greatest tragedy. The "adjustment threshold" varies markedly in different individuals. It is understandable that a hypersensitive, excessively irritable, impulsive, self-centered, infantile and moody person can "take less" than a well-adjusted mature individual and will decompensate sooner when exposed to the same stresses and strains.

"In our hastily formed Army, especially under the draft system, there is a great demand on each soldier for rapid and violent adjustment. Men without any previous military experience, drawn from every conceivable walk of life, are thrown together and subjected to the same discipline, regulations and routine. It is astounding how well and how rapidly many will adapt themselves. However, many others will do poorly and hysterical reactions, psychoses and full guard houses are more than dead weight about the neck of an armed force."[8]

In *Circular Letter No. 19* of the Surgeon General's Office it states: "Not all persons are adaptable to restrictions and inhibitions of personal desires and comforts, to deprivation of rest, food, or shelter, or to the extraordinary demands for prolonged physical and mental activity often imposed by active military service. It must be remembered that many persons with abnormal personality traits who are capable of satisfactory adult adjustment in civilian life, in which numerous avenues of escape are available, will be a total loss to adjust themselves to a pattern which is more or less inflexible and, of necessity, delimited and circumscribed as to self-expression. When thrown on their own meager resources of adaptation in a military environment, in contact with all kinds of personalities, some who are just able to adapt themselves to life under the most favorable conditions, will not fit into the one iron mold which experience has taught is essential to military success."[3]

The symptoms which the patients develop under stress of training or combat are unconscious. They serve a purpose and are defense reactions to danger. The vast majority were not malingerers. Just because these soldiers had a sense of duty, esprit de corps, and of patriotism and could not honorably or safely run away from combat, they developed the unconscious conflicts and consequent symptom formation. The symptoms are for the most part hysterical. They are the result of a conflict between the instinct of self-preservation and the ideas of duty and self-respect. They satisfy the patient's ethical requirements and provide an escape from duty on the ground of physical incapacity.[1]

Man like other animals possesses instincts among which are the reactions to danger. He may stand and use his instinctual mechanism of defense to preserve himself—or flee from danger, not only to seek cover but to create as wide an interval as possible between himself and the instruments that seek to destroy him. The act of warfare meets these biological requirements of defense up to a point where there are trenches and Maginot Lines and organized retreat in the face of overwhelming odds. But the soldier cannot flee before the enemy just because he himself is in danger. He is no longer an individual, but an integral part of a battalion or company. The necessity for courage, loyalty, and self-denial were impressed upon him. Automatic obedience and strict discipline are instilled so that he will react to orders and not to impulse or instinct.[4]

However, "the individual soldier comes into a war with his own personal peculiarities. He comes with his own system of controls which have already in civilian life canalized his instincts along social channels. Further back in his childhood, his infantile aggressiveness and other instincts were subjected to a variety of controlling influences which modified them in such a way that his instincts and biological needs are only satisfied along prescribed socially acceptable

lines. . . . But however much this controlling part of the self is accepted, a perpetual state of strain is present deep in the nature of the mind, so that given sufficient provocation these submerged and now only partly statisfied instincts seek opportunity and find opportunity for operating."

"Frequently in examining the deeper psychology of the neurotic patient of the war, one found many men who stuck patiently to their duties, but who would, after a time, as the result of repeated provocation, break down under the strain. The controlling force, the better self, was no longer able to stand up against the insistent demands of an instinct which demanded either an escape from danger or an aggressive outburst. Powerful conflicts were produced between the instincts on one hand and the controlling force on the other. Where the natural self could find a way out, the soldier was able to solve his conflict by a variety of means, sometimes not laudable from the standpoint of morale . . . by reporting sick, getting around a noncommissioned officer for a soft job, or even courting the prospect of a slight wound which would allow a man to return home with mental peace and the semblance of honor. But this act could not easily be practiced and instead, when the bursting points were reached, hysterical reactions appeared. They were nature's way of obtaining some measure of adaptation, an adaptation which is in the nature of a compromise between instinct on one hand and conscience on the other."

"In cases of hysteria which had lasted sometime and were not cured immediately by the rough justice of disciplinary action or the tactful action of a wise medical officer, the reaction to war danger and stress became linked up with other conflicts in the mind which existed before the period of war service. No soldier came into the war with his mind a clean slate; it had already been written over with the story of his past experiences and conflicts. Former dangers and conditions of insecurity had either been met or had set up difficulties. Conscience had already made the coward and the courageous. The relatively mild analogues of war conflicts had already existed in civilian life. (There had been stresses and strains and causes for anxiety before.) It, therefore, did not take much time for the neurotic reactions to the war to weave themselves into the pre-existing neurotic disposition which had grown up in peacetime. It was for this reason that Emanuel Miller came to the conclusion that the cure of the hysteria of the war became in a large measure the resolution of mental problems of peacetime. Many patients with wartime neurosis, particularly those who broke down early, were found on deep analysis to be associated with long-standing feelings of insecurity. Such men were found to have spent their lives either in sheltered places or had old family ties which had thrown the responsibility for security not upon them, but upon their parents. . . . To them the establishment of new ties was difficult. Strangers could not be tolerated, new surroundings could not be assimilated. They felt themselves like strangers in a strange land and in a strange land full of dangers."

"One of the peculiar aspects of human psychology, discovered through the work of Freud, is the depth to which a man can really love himself. This love of self is not merely an expression of the self-preservation instinct, although this enters into it, but a primitive, childish, self-esteem which cannot be wounded.

Persons in whom this trait is strongly developed succeed in life admirably when they receive praise and become the centers of attention. They are not only pathetically preoccupied with their own achievements, but are sometimes even satisfied with their own selves as audience. They are proud of their bodies . . . and are literally in love with themselves. In warfare, such characters find it difficult to fit in with the group life of a regiment unless it affords them opportunity for self-expression; and when they are courageous, as they may be, it takes the form of seeking for decorations and applause. Such men, however, are terrified at the prospect of a wound, and the possibility of injury rules out all idealism. They are not the individuals who would face death for a cause. This type is prone to hysterical manifestations, to fugues and sometimes to major mental disorders. They cannot face the horrors of war, not because of sympathy for the slain, but because they identify themselves with every mutilation and death which the soldier has to witness. . . . Stated simply then, it is the conflict between conscience and instinct that can be regarded as the central motive around which all the clinical manifestations seem to collect."[4]

A clinical survey of the first group of invalid soldiers to be returned to Australia from abroad reveals some interesting facts.[5] Of 208 cases studied, 61 were due to diseases of, or injury to, the nervous system. A great majority of the patients suffering from anxiety states gave a history of previous nervousness or breakdowns. Careful inquiry into the past histories of these patients showed that they were capable of "carrying on" in civil life in spite of minor breakdowns; but the strain of military life in active service quickly revealed their mental instability. A large number might have been excluded from the Army if a truthful history had been given in the first place.

Captain John M. Caldwell, of the U. S. Army, reported the results of an intensive study of 100 American soldiers who developed psychoses during peacetime.[6] His conclusions were "the cause of schizophrenic psychoses in the United States Army is not found in any peculiar or particular demands of the service. However, the change from a familiar to an unfamiliar environment with added stresses and strains, probably plays a part in bringing latent trends to the surface. Abnormal sexual drives to a large degree are associated with the development of the psychoses and probably act as precipitating factors."

A report was published of 200 consecutive admissions to the Christian Street Hospital in Canada, in the year period from October, 1939, to September, 1940.[7] The cases included constitutional psychopathic inadequacy, mental defectives, epileptics, psychotics and psychoneurotics, alcoholics and malingerers.

Environmental and hereditary factors were investigated. In over 50 per cent the physical and mental health and economic status of the families were classified as poor or bad. Only 68 per cent showed both parents alive when the patient reached the age of 14. In eleven cases, parents were separated, seven were brought up in an orphanage, two had been adopted, and two were illegitimate.

With regard to education, thirty-two were illiterate and one hundred did not pass examinations on leaving public school. Most of these left school for no good reason. Sixty per cent had no trade; 51 per cent have had long periods of

unemployment, no settled occupation or required assistance from the family or authorities; 17 per cent had been in difficulty with the police. This included arrests for vagrancy, drunkenness, theft, and assault. Twenty-two cases were backward and eight had attended special school for backward children. Eighteen gave a definite history of a previous psychotic episode, seven of whom had actually been in a mental institution. Thirty-five had required attention for neurotic disorders prior to enlistment.

It was felt that the unsuitability should have been obvious in a majority of these patients on enlistment or in the primary training period. Often it had been recognized that the man would not make an efficient soldier and nothing was done about it. They were sidetracked on regimental duties, fatigues, etc.

In only twenty-six were strain, change of surroundings, alteration of diet, separation from families, etc., considered significant with regard to appearance of symptoms. None of those was definitely associated with war strain.

IMMENSITY OF THE PROBLEM

Even before our nation entered the war in 1917, many warnings were sounded by the French and British concerning the grave seriousness of neuropsychiatric disorders in the armed forces of that day.[8a] The seriousness was emphatically brought home by a report finally rendered by the chief of the division of neurology and psychiatry of the United States Army on September 5, 1918: "Everything seems to point to our soldiers developing neuroses to a degree even greater than has occurred among the British. . . . The conditions of American life have been such that a young man suddenly taken from his surroundings where he more or less always had his own way, where obedience was never necessary, where he was taught that he was the equal of everyone, suddenly taken from surroundings of that character and forced to obedience, forced to face all this war . . . it would not be surprising if he showed his reaction to the change by developing a neurosis. . . . French neurologists have spoken of the excessive nervousness of American soldiers who have been under their care."[8b]

It developed that "whereas mental illness had been almost wholly ignored and the medical advances before the war dealt almost exclusively with physical diseases, the wide prevalence of the neuroses among soldiers was apparently leading to a revision of the medical and popular attitude toward mental and functional nervous diseases, and stimulating widespread interest in their observation and study."[8a]

"Many things were learned quickly in the war of 1914 to 1918. Although many physical disabilities could be waived, and although many of them disappeared with treatment or favorable conditions of military training, it was usually the opposite in cases of nervous or mental diseases. Such men were only too often singled out only after a considerable period of training, during which time they received pay, equipment and maintenance, wasted the time of instructors, interfered with training and filled hospital beds urgently needed for others. Many of them would have been better off to all concerned, if not even of material assistance to their country, had they been left in their accustomed

surroundings. If they became soldiers, they were almost certain to present eventually a serious economic problem to the nation in the form of government hospitalization and care."[8d]

"Neuropsychiatry was a new field in the war of 1914 to 1918. It interfered with established military routine and order and no doubt had a struggle in hastily orienting itself in this new situation. Officers complained that if specialists did not cease eliminating the unfit, there would be no Army left. It was felt that training which transformed poor physical specimens into robust fighters could do the same for those who had nervous or mental disabilities. As a result, recommendations for rejection or discharge were often waived by line officers. Eventually it was discovered that the nervous and mentally unfit were greatly embarrassing the American Expeditionary Forces. On July 15, 1918, General Pershing urgently cabled the Chief of Staff that more intensive effort be made to eliminate such men. After this, rejections and discharges were carried through with less difficulty."[8c]

"Although many conditions were clear-cut and sufficient for outright rejection or discharge, others were more difficult. These proved to be constant sources of annoyance and trouble to the officers, forming the larger number of the absentees, the discontented, the inefficients, the inmates of the guard house, and the frequenters of the regimental infirmary. These were the cases which complained of being dizzy, faint and bewildered at critical moments."[8d]

"It was said that no other class of men made for so much mischief in the United States Army as did the feeble-minded. Their records prove that physical health, strength and ability to get along in civil life did not, in themselves, insure satisfactory Army service. The strange and exacting environment of the Army was too much for them."[8d]

"The need for routine neuropsychiatric examinations of commissioned officers was expressed."[8e] "A startling number of defects was found among those attending officers' training camps, and it was felt that if all candidates for commissions had been subjected to a thorough neuropsychiatric examination, many would have been rejected with advantage to the military service. In fact, this failure was said to be probably the outstanding defect of the neuropsychiatric service."[8f]

"That the initial examination was important was demonstrated by the fact that 27,836 neuropsychiatric cases, or 40% of the total reported, were discovered during the preliminary examinations of recruits and draftees."[8f]

"The United States Navy, too, was not without its difficulties. The psychopath received particular attention. Quoted newspaper stories demonstrated how undesirables were urged to enter the armed forces. For instance:

"Dec. 16. Thief dismissed so that he might join the Army. D. F. pleaded guilty here today on a charge of petty larceny . . . but an indictment against him charging forgery . . . was dismissed so he might enlist in the . . . United States Army."[8g]

"In a survey of inmates of naval prisons, it was concluded that 54% are men who clearly should have been eliminated at the recruiting or training station."[8h] "Another naval writer's experience points to the fact that the psycho-

path has more difficulty adjusting himself to the service than has any other type of questionable individual. A recruit in this classification is not amenable to discipline and he ordinarily cannot comfortably be assimilated in any part of the organization without having an influence on morale."[8i]

"Eventually it evolved that from April, 1917, to December, 1919, 95,577 officers and men (both Army and Navy) were admitted to hospitals for mental disease in this country and abroad, and 41,976 were discharged for disability incidental to mental disorders in the same period."[8j] "Also of 54,117 ex-members of military service hospitalized by the Veterans' Administration, approximately 60 per cent were hospitalized because of neuropsychiatric disabilities, and cost the government almost $1,000,000,000 in the past fifteen years."[8k] "Even with the exclusion of paresis, mental deficiency, psychopathic personality and chronic alcoholism, two out of five veterans receive pensions because of neuropsychiatric disability."[8l] "Three of seven men discharged for disability from the Army in 1939 were suffering from mental disease, and suicides ranked second as major cause of death in the Army for that year."[8]

Similarly in the British Army, statistics from the last war showed that one-third of the unwounded, and one-seventh of those discharged were permanently unfit because of functional neuroses and mental disorders.[9]

TREATMENT

With regard to treatment of patients suffering from war neuroses in the field, the first essential when the patients arrive at an aid post is to convince them that they have received no serious injury. When confusion, excitement, loss of memory and disorientation are the chief symptoms, rest, warmth, hot drinks with plenty of sugar, and a dose of bromide or phenobarbital will be necessary. Restless or excited patients may be given a hypodermic injection of morphine or soluble phenobarbital combined with hyoscine. When hysterical symptoms predominate, an attempt should be made to remove them by suggestion.[2]

According to one English Army physician (Dillon), during the World War 63 per cent of the patients suffering from so-called acute anxiety states were able to return to duty after treatment which consisted primarily of rest and sleep, and relapses occurred in only 5 per cent.[9]

In cases that do not respond quickly, the prognoses are not as good and more intensive and prolonged psychotherapy is necessary. Such procedures as hypnosis, suggestion under narcosis, suggestive physiotherapeutic measures, and psychoanalysis have been used by various authors with reported good success. Many patients will, no matter how treated, become chronic invalids and require government care for the rest of their lives.

The major factor in the prevention of war neuroses is the detection and early rejection or elimination of the emotionally unstable from active combat service. This can be done if there is a greater awareness of the problem in medical circles. Physicians on induction boards should have a psychiatric as well as physical orientation and approach. Any lack of psychiatric awareness that does exist is but a reflection of the state of affairs in the medical profession in general.

However, the lesson of the World War was well learned, and it is significant that the Surgeon General has requested that medical officers examining applicants for the Army be especially alert to detect all those with any mental or nervous abnormalities who later may disrupt discipline and morale, retard progressive military training, occupy hospital beds urgently needed for acutely ill patients and finally become an economic burden to the government.[3]

If greater attention were paid to the following statement of the Surgeon General, this immense problem would in great part be solved: "The Army is one of the elements of national defense, and its present mission is one of preparation for an offensive-defensive type of warfare. It is in no sense a social service or a curative agency. It is to be considered neither a haven of rest for wanderers nor a corrective school for misfits, ne'er-do-wells, feebleminded persons or chronic offenders. Furthermore, it is neither a gymnasium for the training and development of the undernourished or undeveloped nor a psychiatric clinic for proper adjustment to adult emotional development. Therefore, there is no place within the Army for physical or mental weaklings, potentially psychotic or prepsychotic persons or behavior problems. Men who present behavior problems in the civilian community will certainly present intensified problems in the service."[3]

NEUROSIS IN CIVILIAN POPULATIONS

With regard to the problem of war neuroses in civilian populations, the general experience in Britain so far bears out the report of a conference of medical men convened before the active stage of war began. They stated that an exaggerated estimate had been formed of the liability of war to produce nervous breakdowns. This has received substantiation since the intensified air raids on Britain have been in progress, for few nervous breakdowns have occurred in spite of the suffering and material loss.[10]

The best remedy against panic and disruption for civilian populations lies in the active participation of as large a section of the population as possible. A lesson is to be learned from the Germans, who state there are no shoemakers in Germany any more, they are all fighters on the shoemaking front. Democracy too often leads to an attitude of what do I get, with a disregard of what can I give.[11]

Aggressive impulses of the people should be mobilized along certain definite channels. Each individual as far as possible should be given an active part to play. Training in first aid, instruction in modern methods of warfare, the nature and effects of high explosives and gases should not be kept as a mystery from the average citizen. He should also be taught the importance of the so-called fifth column in modern war and what measures are necessary to counteract it. Another error has been an excessive concentration of the public mind on safety first. There has been far too much talk of where to hide and how to protect one's own skin, of keeping up the morale of the nation, and of preventing panic. There has been too little talk of how to defeat the enemy. People were getting the feeling that one had only to sit and wait long enough for the enemy to be defeated without personal danger. This was the philosophy of the Maginot Line and it was a psychological disaster. It led to the feeling that we had only to produce enough machines, enough concrete and enough airplanes and to pour out enough money to win the war.[11]

REFERENCES

1. Wechsler, I. S.: Textbook of Clinical Neurology, Philadelphia, 1931, W. B. Saunders Co.
2. Foreign Letters: London, War Neuroses, J. A. M. A. **114**: 424 (Feb. 3), 1940.
3. Neuropsychiatric Examination of Applicants for Voluntary Enlistment and Selectees for Induction, Circular Letter No. 19, Surgeon General's Office, J. A. M. A. **116**: 2509 (May 31), 1941.
4. Miller, Emanuel: The Neuroses in War, New York, 1940, The Macmillan Co.
5. Foreign Letters. Australia, Causes of Invalidism in Military Service, J. A. M. A. **116**: 2610 (June 7), 1941.
6. Caldwell, John M., Jr.: Schizophrenic Psychoses, Am. J. Psychiat. **97**: 1061 (May), 1941.
7. Baillie, W.: A Summary of 200 Neurological and Psychiatric Admissions From the Canadian Army Service Forces, Am. J. Psychiat. **97**: 753 (Jan.), 1941.
8. Quoted by
   Aita, J. A.: The Problem of Neurologic and Psychiatric Examination During Military Mobilization. I. General Considerations, Proc. Staff Meet., Mayo Clin. **16**: 283 (April 30), 1941.
   a. Bailey, Pearce, Williams, F. E., and Komora, F. O.: Organization. In: The Medical Department of the United States Army in the World War; Neuropsychiatry, Washington, D. C., 1929, U. S. Government Printing Office, Vol. 10, pp. 5-22.
   b. Salmon, T. W.: General View of Neuropsychiatric Activities. In: The Medical Department of the United States Army in the World War; Neuropsychiatry, Washington, D. C., 1929, U. S. Government Printing Office, Vol. 10, pp. 273-302.
   c. Bailey, Pearce: Provisions for Care of Mental and Nervous Cases. In: The Medical Department of the United States Army in the World War; Neuropsychiatry, Washington, D. C., 1929, U. S. Government Printing Office, Vol. 10, pp. 39-55.
   d. Bailey, Pearce: Detection and Elimination of Individuals With Nervous or Mental Diseases. In: The Medical Department of the United States Army in the World War; Neuropsychiatry, Washington, D. C., 1929, U. S. Government Printing Office, Vol. 10, pp. 57-86.
   e. Bailey, Pearce, and Haber, Roy: Occurrence of Neuropsychiatric Diseases in the Army. In: The Medical Department of the United States Army in the World War; Neuropsychiatry, Washington, D. C., 1929, U. S. Government Printing Office, Vol. 10, pp. 151-156.
   f. Bailey, Pearce, and Haber, Roy: Analysis of Special Neuropsychiatric Reports. In: The Medical Department of the United States Army in the World War; Neuropsychiatry, Washington, D. C., 1929, U. S. Government Printing Office, Vol. 10, pp. 157-269.
   g. Stearns, A. W.: The History as a Means of Detecting the Undesirable Candidate for Enlistment With Special Reference to Military Delinquents, U. S. Navy M. Bull. **12**: 413 (July), 1918.
   h. Jacoby, A. L.: Psychiatric Material in a Naval Prison at Portsmouth, N. H., U. S. Navy M. Bull. **12**: 406 (July), 1918.
   i. Sullivan, H. S.: Psychiatry and National Defense, U. S. Navy M. Bull. **37**: 273, (April), 1939.
   j. Strickland, B. A.: The Importance of Psychiatry in Military Medicine, The Military Surgeon **83**: 83 (July), 1938.
   k. Winslow, C. E. A.: The Strength of the Nation, McCall's Magazine **68**: 18 (April), 1941.
   l. Baganz, C. H.: The Importance of a Proper Psychiatric Survey in the Enrollment of Personnel of Military Forces, The Military Surgeon **86**: 471 (May), 1940.
9. Dillon, F.: Neuroses Among Combatant Troops in the Great War, Brit. M. J. 2: 63 (July 8), 1939. Abstracted in Arch. Neurol. & Psychiat. **45**: 168 (Jan.), 1941.
10. Langdon, Brown W.: Mental Health in War Time, Nature **147**: 193 (Feb. 13), 1941. Abstracted in J. A. M. A. **116**: 1774 (April 19), 1941.
11. Rogerson, C. H.: Correspondence, Am. J. Psychiat. **97**: 969 (Jan.), 1941.

WAR NEUROSES. EXPERIENCES OF 1914-1918*

Lessons for the Current Emergency

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IT IS difficult to discuss the war neuroses as they occur during active service without thinking in terms of what precedes active service, and although you have undoubtedly heard a good deal about that phase of military activity, it may be necessary to repeat a bit of it in order to get oriented. I think we can say that the last war contributed more to psychiatry than psychiatry did to the war. I mean that the last war gave psychiatry a certain professional standing which has continued, and after the war it was found that various foundations and organizations recognized psychiatry as a branch of medicine worthy of support. I said recently that the problem of war neuroses is a three-dimensional problem. Its length reaches from war to war; the neuropsychiatric casualties of the last war still remain on our hands, and the effect of the current conflict already begins to reveal the unstable personalities in our civilian population and bring new casualties. The neuropsychiatric casualties of the two wars are overlapping. We still have some 68,000 neuropsychiatric disabilities in the government hospitals from the last war. The report of the administrator of Veterans' affairs indicates that they represent 58 per cent of all patients being cared for by Veterans' Hospitals. The economic aspect of the problem is appalling when one considers the money spent on treatment, training, and compensation. It can be said that the war neuroses begin early. They are long drawn out, they are difficult to treat, and they tend to increase for at least twenty-five years after the cessation of hostilities. It has been estimated that it costs $30,000 to care for a psychiatric disability from the time the individual breaks down until his death. We have some twenty-eight hospitals in this country caring for these 68,000 patients.

The provisions for detecting these potential neuropsychiatric disabilities before they get into service are shockingly limited and inadequate. The Government will employ a few psychiatrists at a rate of $15.00 a day and is expecting them to examine anywhere from 150 to 200 patients a day. I have pointed out to the administration that if one psychiatrist picked out but one potential psychotic every six and one-half years, he would save his salary. There is a pressing need for a careful psychiatric examination before induction of men into the military service.

The neuropsychiatric disabilities resulting from active military service represent what we call the war neuroses, and what the British used to call "shell shock." The latter term represented the viewpoint of British pathol-

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ogist Colonel Mott at the time of the last war, who felt that "shell shock" was an organic condition produced by minute, petechial cerebral hemorrhages. The role of psychological factors in "shell shock" was minimized. It was, however, recognized eventually that a great many of the soldiers diagnosed as "shell shock" casualties had not been anywhere near a shell. This group of "shell shock" cases proved to be made up of most heterogenous neuropsychiatric disorders, so varied that it would be of little value to classify them. In order of their frequency the neuropsychiatric disabilities of the last war were neurasthenia, conversion hysterias, anxiety states, and psychoses. We did see some mentally defectives, but they represented a small group, for about 30 per cent of all the individuals eliminated before they went into service were disqualified because of mental deficiency. There were nearly 70,000 cases disqualified as constitutionally unstable individuals, potential psychotics, epileptics, and feeble-minded.

The neuropsychiatric casualties must be considered in relation to three phases of the state of war: the period of mobilization, the period of active service, and the period of demobilization. It was recognized and the point was stressed during war activities and later in civil life that there are limits to the amount of physical and mental stress that any individual can withstand without breaking down in his adaptation to life. These limits are not static; they vary from time to time in the same individual, and they vary, of course, from one individual to another. I happened to be at the Boston Psychopathic Hospital when the last war broke out, and we had many individuals coming in immediately after war was declared. Their delusions and hallucinations were colored by the war activities, colored by what they were reading in the press and saw at the movies. In other words, it took no more stress in these particular individuals than the simple declaration of war to bring out definite psychotic symptoms and break down their adaptation to life. At the present time we find individuals who have been making a good adjustment to civil life under demands which have not been too successful, but who have developed all kinds of anxieties and hysterical manifestations under the stress of mere anticipation of being drafted. A mere threat of war is enough to break down what appeared to be a good adjustment to the demands of civil life. Many individuals of this type will be weeded out; others will get into active service and will go to the camps. There they will be subjected to the stress and strain of making an adjustment to army life in an environment where discipline is strict, where they have to adjust to groups of individuals living intimately, dressing and undressing and looking after their personal needs under conditions that are embarrassing to the shy and diffident individual, and being subjected to teasing, razzing, or becoming the "goat" of the crowd. These individuals, able to go through the first stages, begin to break down when they are subjected to stresses and strains of army life. Then, after war is declared, and as we begin to embark and think in terms of getting overseas, another group of individuals begin to break down anywhere from the port of embarkation up to the front-line trenches. There were, however, individuals who went through all these phases with no evidences of failing to meet the responsibilities and obligations of army life, but who broke down on the way back to the safety zone—a sort

of delayed reaction. If the war had continued, there would undoubtedly be many more individuals hitherto intact mentally and physically who would have developed neuropsychiatric disorders.

Studies made of the constitutional background and the psychopathic taints do not show a great deal of difference in the hereditary background of those who broke down and those who were sufficiently stable to carry on. In general figures it can be said that we found 5 per cent of poor inheritance in the "shell-shocked" soldiers, compared with 2.5-3 per cent in those who were considered stable. There was a difference, but it was not marked. There was, however, a marked difference in this respect between the soldiers who broke down overseas under battle, under the stress and strain of the firing line, and those who broke down before they went overseas. The latter showed a marked constitutional neuropathic disposition, and their neuropathic background indicated that they were definitely unstable.

In my experience, "shell-shocked" soldiers seen en masse on the wards did not measure up in their personality make-up to the average sick soldier cared for in a general medical hospital. If you went into a hospital for "shell-shocked," you would recognize in a relatively short time that you are dealing with a group of individuals who, on the whole, are rather inadequate. It is interesting, too, to keep in mind the effects of different types of psychic trauma on different individuals. We find a great many men who went through the war, went "over the top," were right in the thick of battle, were subjected to all the strains of active warfare, showing no evidence of strain, who came back and developed a severe neurosis during the economic depression which followed demobilization. We found many men carrying on perfectly well as soldiers overseas, who would crack-up after hearing that their wives were sick or that the son died. Different individuals seem to be affected by different circumstances, stresses, and strains. One individual seems to be more susceptible to fear and others to grief. A threat to one's reputation, loss of self-esteem and prestige are factors that affect some individuals more than fear or grief.

During the last war about 2 per cent of those engaged in active service overseas developed "shell shock." One may say either that the 2 per cent represented the wholly unstable group, or that the other 98 per cent were unusually stable. I think it is logical to look upon the 98 per cent of soldiers who withstood the test of active service as representing the normal individuals, while the 2 per cent, for some reason or other, represented the unstable group.

It is of interest to point out that those individuals who represented the top 10 per cent in their psychological examinations as given in the camps were the individuals who, on the whole, made the best soldiers. They were better adjusted, and more frequently were selected as noncommissioned officers. In the lower 10 per cent were found the maladjusted group, the individuals who got into difficulties. We found these individuals more frequently in the guard houses and among those who went A.W.O.L.* They were the boys who were teased and harassed by their companions. It is among this type of men that the "shell shock" was most frequently found. I think this observation will be substantiated by the observations made in camp as time goes on.

*"Absent without official leave."

The neuropsychiatric casualties at the front varied in numbers and depended a good deal upon the severity and duration of the preliminary engagements and skirmishes which preceded big drives. At Chateau-Thierry, for example, about 20 per cent of the casualties were neuropsychiatric casualties, because the man had been subjected week in and week out to stressful experiences before they went into the actual battle.

It is recognized that a neurosis serves a purpose in the life of the individual. It has a protective mechanism. Trotter used the term "herd instinct" to denote such attitudes as loyalty, patriotism, honor, etc. He pictured this herd instinct and the instinct of self-preservation as the two forces which came in conflict and could only be dissolved by the neurosis. We tried to evaluate just what purpose the neurosis served in a soldier.

If one thinks in terms of the war neuroses as being a protective mechanism, we have to go back some years. The war neuroses were first recognized, I believe, by the Russians in 1905 and 1906, and provisions were made to care for these neurotic cases. That was the first time any recognition was given to the fact that war produced mental casualties and that these mental cases needed consideration on equal terms with other types of war casualties.

In the last war, the medical men, the military authorities, the public, and the press accepted the fact that "shell shock" was an illness not due to any malicious intent on the part of the soldier. Thus, the "shell shock" became by the same token a legitimate way out of a difficult situation. When war began, the herd instinct was a major driving factor for most of the men who enlisted or were drafted in the army. The feeling of self-esteem, the honor in which the individual wants to be held by his friends, by the community, by the military authorities, and by everyone else with whom he comes in contact, and the propaganda, speeches, the bands and parades, the uniform, the pride in being a soldier, the fact, too, that becoming a soldier oftentimes solved a good many conflicts of one's civilian life, such as worries and anxieties of an economic situation, or of a marital or professional difficulty, all those things contributed in building up this herd instinct. To join the army, to go to war, was the thing to do. It gave the individual a sense of importance and a sense of security. It enhanced his feeling of self-esteem. Nothing else mattered. The herd instinct as it related to the war was high, and the instinct of self-preservation was quiescent. One was not thinking in terms of life and death but rather in terms of satisfying certain emotional drives. However, as one became more actively engaged in military service, as one approached from the camps to the ports of embarkation, certain aspects of the glory and the glamour of the uniform were lost by doing kitchen police work and being subjected to an iron-bound discipline of the army. A good deal of this herd instinct began to fade away. The enthusiasm began to subside, and the instinct of self-preservation began to rise. As they neared the front line, the herd instinct became counterbalanced by the instinct of self-preservation. In those individuals who carried on, of course, the herd instinct was always higher, and the instinct of self-preservation remained submerged, while in those individuals in whom fear, anxiety, the emotional tension were of such a degree that the sustained threats

to their physical security could not be held in check by the herd instinct, severe emotional conflict resulted. The "shell shock" or the neurosis served the purpose of satisfying both drives, for it was recognized as a respectable way out of a difficult situation. It allowed the individual to protect his own self-esteem, because "shell shock" was looked upon as a legitimate cause for military incapacitation by the officers, by the doctors, and by brother soldiers, and at the same time it satisfied the instinct of self-preservation. It was a solution of an intolerable dilemma.

There were three ways of solving the conflict between the instinct of self-preservation and the herd instinct. One was to get killed, the second was to get wounded, and the third was a neurosis. We rarely saw a "shell-shocked" soldier, a neurotic soldier, who had a wound. The wounded individual didn't need a neurosis. He was out of the situation by virtue of his wound. Occasionally, the neurosis developed among wounded soldiers when the time came for their discharge, and they were confronted with the situation of having to go back into active combat. On the whole, one did not find neurotic soldiers among wounded.

Another interesting observation is that the neuroses were less frequent among the professional military men than among men who went into military service from civilian occupations. Thus, the English Army was, so far as the officers were concerned, made up to a large extent of professional soldiers. It was somewhat different in our Army where an officer might have been an insurance clerk or a lawyer or a business man, who went to one of the R.O.T. camps, and in the course of six or nine months became an officer. I do not believe I ever saw an hysterical paralysis in an English officer. I have seen a few neurasthenics, but, on the whole, the war neuroses were relatively few among English officers. They were trained for a life job, and consequently, were better adjusted to stresses and strains of war. Among the American officers, however, we often observed individuals suffering from a paralyzed leg, paralyzed arm, blindness, or some other hysterical symptoms. I remember, also, two or three high ranking medical officers coming to hospital with an hysterical paralysis, the sort of thing you would not believe compatible with a physician's knowledge of the nature of hysterical symptoms.

The neurasthenia and hysteria were the most common types of neuroses encountered during the last war. We saw relatively few cases of conversion hysterias with physical incapacities like paralyzed arm, leg, blindness, etc., in officers. We saw them frequently in the soldiers. A soldier with hysterical incapacity invariably represented an individual who met and solved the conflict between his herd instinct and his instinct of self-preservation at once, without putting much into it. The neurasthenic was, on the contrary, an individual in whom the internal elaboration of neurosis was more insidious. He went in and out of the front line trenches, he may have a good many symptoms such as insomnia, perhaps some battle dreams, feeling of exhaustion and fatigue, tremors and other symptoms, but he kept going in and out until he reached the point where he was no longer able to carry on. The hysterical individual met that situation more crudely. He was satisfied oftentimes with a group of symptoms that seemed so completely incompatible with his education, his back-

ground, his whole understanding of what that situation meant. The hysterical soldiers, as a whole, were more easily treated than the neurasthenics. They recovered from their symptoms more easily also, because they were eminently suggestible individuals, but they were also very much less likely to remain without relapses.

It was recognized early in the war that acute cases of war neuroses had to be dealt with promptly. It was found that cases with anxiety states, with hysteria, and with neurasthenic symptoms, which were sent back to the general hospitals along with the general medical and surgical cases were most difficult to treat effectively. Oftentimes they would be picked up with the general medical cases and simply remain for weeks on the wards of a general hospital, getting little or no psychiatric attention, their symptoms becoming fixed, and as a result of being in the wards with medical and surgical patients with organic symptoms, the whole picture became more elaborate and difficult to treat. That situation was bad also for the physically sick patients, as you know. For these reasons, receiving centers were set up within 5 to 10 kilometers from the front lines with psychiatrists on duty who saw all sick men as soon as they came back from the front. Thus, many of the soldiers who developed neurotic symptoms in action got no farther back than perhaps 5 to 8 kilometers from the front lines where they were treated. Many of these were cases of acute fear reactions plus exhaustion and fatigue. From 60 to 70 per cent of all such cases were returned from these centers back to the front line trenches within forty-eight hours. These centers did a useful work in segregating the cases. If all the neurotic cases had been indiscriminately evacuated to base hospitals, permitting a long period for the neurosis to become set before treatment could be started, undoubtedly many soldiers with milder neurotic states would never have returned to the front, and a large number of soldiers who well might have developed a chronic neurosis were thus salvaged for the service.

The amnesia cases represented a particularly interesting group, because these individuals attempted to solve their conflict between the herd drives and those of self-preservation by completely obliterating the memory of the intolerable situation. "Forgetting" allowed the man to carry on with duty, and one rarely saw the amnesic patient with any other neurotic symptoms. Sometimes the amnesia would be restricted to a rather short period in the individual's life, covering a space of time of perhaps a day or two preceding some trying event and extending beyond for two or three days. Other individuals would have a complete anterograde and retrograde amnesia lasting for weeks and months, forgetting completely all that happened before and after the event which produced the amnesia. There were also peculiar types of partial amnesia with confusion in which the individual would remember people and certain incidents but couldn't identify them with any particular situation.

The therapy of war neuroses varied with the different schools of thought. Some felt the approach to these problems was through analytical procedures and others felt that suggestion and hypnosis were more useful. It was important that patients got in and out of the hospitals as quickly as possible, and

one had to think in terms of methods that were practical. For that reason, a large number of the conversion hysterias who were undoubtedly precipitated by suggestion were treated by countersuggestion aided by faradic current ("suggestion armée" or "torpillage" method of the French). A patient incapacitated by an hysterical paralysis of the leg would be carried along at the hospital somewhat as follows: The doctor would take a history and endeavor to get on friendly relations, finding out all he could about the early history of the soldier's home life, interests, hopes, ambitions, attitude toward the war, resentments, attitude toward superiors, homesickness, fears, etc. Then a careful neurological examination would follow with any other examinations and laboratory tests that seemed advisable. Every psychiatrist had his own technique of treating his patients. One might start out as follows: "Now, John, you want to get well. You want to get over this trouble. You don't want to carry a bad leg around with you all your life, do you?" John would usually agree that he did want to get well. He would be taken off the ward to a treatment hut with a medical sergeant or corporal, and the psychiatrist would make another short speech, saying, "John, we are going to treat you and you are going to be absolutely cured when you go out of this place. That, I take it, is what you want?" Nothing short of that dogmatic assertion had any real value as a suggestive measure. John would say "Yes," a little less enthusiastically than he had before. There are a few psychological tricks, such as, "Lock the door, Sergeant." Then you tell John that the treatment may be very short or it may take some time, "It may take five or ten minutes, or it may take all day, John, but when you get out, you are going to be well; that is the important thing." "Now, John, this may be a rather painful procedure—does that bother you?" He would usually say "No," he just wanted to get so that he could walk. The hysterical patient was always very urgent in protesting against the illness and wanting to get over it. The electrical current would be applied and increased as found necessary, with continuous suggestion that function was to be restored. It is purely a matter of suggestion, and in a surprisingly short period, with the use of the current and help from patient, the muscles would contract; then the contractions would take place without the current. You show him, talk about it, demonstrate to him that there was function. Under the stimulation of the current the leg would jerk, and he would get cramps, some of them painful, and under the excitement he would find that he could move the leg, stand on it, walk. It was always desirable to spend a certain length of time with the patient after function had been restored, explaining the purpose of the paralysis, how it may come back under stress, and ways and means of preventing a recurrence of difficulty. After restoring function, the patient always was returned to his ward for the psychological effect on other patients. Went out in a wheel chair, returns under his own power! On the other hand, if a patient was not cured at once, he would not be returned to the same ward for obvious reasons. The neurasthenics and other types of neuroses did better under some modification of analysis, persuasions or re-education.

Sixty-five per cent of the cases of war neurosis were sent back to active duty, 30 per cent went to the service of supplies, and 5 per cent were found

unfit for military duty. The classifications used for the neuropsychiatric disorders were neurasthenia, psychasthenia, hypochondriasis, hysteria, anxiety neurosis, anticipation neurosis. Most of the anticipatory cases were those individuals who developed neurotic symptoms before they had engaged in any actual war activities. The individuals suffering from effort syndrome or neurocirculatory asthenia were common. They are being recognized at the present time by the examining boards and are considered as being unsuitable for service. There were many cases of exhaustion associated with a mild anxiety state.

I believe that the effects of the present war will not be particularly different from those seen in the last war. It is difficult to see how we can eliminate the unfit when the time of psychiatric examination is limited to six or eight minutes. In many of these cases the unfitness of the individual has to be determined by the evidence obtained from the individual's past history rather than on the basis of signs and symptoms the psychiatrist may discover during a short examination. Already examiners are finding men in the Army who have been in state hospitals or were released from state hospitals only a few weeks before their induction into the service. The attitude of some of the military authorities is still expressed thus: "You give us the men, and we will make an Army out of them." The fact, however, is that a man may be able to make a very satisfactory adjustment to civil life, and yet this is no guarantee that he will make a good soldier. The demands of the Army on the individual are quite different from those of civil life. Many a neurotic individual makes a fairly good adjustment to civil life, he may fit into the social scheme of things, he may be a pretty good father, husband, friend, and neighbor, and yet he is quite unsuited to meet the demands of military life. It is not possible to eliminate all the potential psychoneurotics. A certain number of them will be picked up before they get into service, others will break down when they get into camps, and still others on the way to battle lines. On the whole, it seems to me we are going to be confronted with the same kind of problems during the period of mobilization and active service as we had in the last war.

I spoke of a period of mobilization and of active service. I think the period of demobilization is a period quite as important in creating the neurosis as any other in the experience of the soldier. The methods utilized in demobilizing, and the various services that the government has set up for compensation treatment of war disabilities, for training in various professions, have created potent motives for neurotic manifestations in certain individuals. I believe that following the last war these procedures of demobilization created many neurotics. When you pay a man for being sick, penalize him for getting well, when you push him into highly specialized organized occupational schools, giving him a false idea that he is going to become a good engineer, good public accountant, while he is totally unsuited for that sort of thing, you create a great gulf between man's fanciful ambitions and the grim reality of his actual abilities to achieve these ambitions.

The war neuroses are not different from the neuroses we see in civil life. I think, however, that war neuroses are much more amenable to treatment than

the neuroses seen in civilian life. Created by suggestion, the war neuroses are readily helped by suggestion. There is a certain prestige of being an officer and in utilizing the therapy of suggestion. There is a greater prestige relationship between the soldier and the medical officer than there is between the patient and the doctor in civil life. In civil life, if the patient doesn't like one doctor, he can seek another. The soldier has no such rights. An important lesson we learned from the last war is that the nearer these neurotic manifestations can be treated to the place of their occurrence, the easier and quicker they are cured. If the neurotic individuals are treated at the receiving centers immediately behind the front lines and soon after their symptoms developed, a great many of them can be sent back within a short time. On the contrary, the most difficult cases to deal with were the cases evacuated from the front lines to general hospitals far in the rear. They just hung around and simulated symptoms seen by them in others, while their own neurotic manifestations would become chronic and fixed.

Question: Was there a difference in the incidence of "shell shock" and neurosis in the English and in the American troops?

Answer: I don't think there was any significant difference between the Americans and the British. We did, of course, make more careful examinations, poor as they were, before the induction into service than the British did. In England the men were thrown into service at first without much time for psychiatric examinations. They did have the same sort of sifting process in the British Army but not to the extent that the American Army had. The incidence of neuropsychiatric casualties was not particularly different.

Question: What immediate measures did you use for treatment of neurotics at the front lines?

Answer: Right at the front trenches these men were given rest. Reassurance was an important part of treatment. A good many of them had fear of being looked upon as cowards, and they were anxious to get back. Sedatives were used. It was a matter of bucking the morale of the discouraged soldier. Two out of three soldiers who came there from the trenches would be relieved after a night's sleep, rest, and reassurance that they were all right and not "yellow," and back they would go. They rarely were kept more than seventy-two hours.

Question: Did they go back to the same posts in the trenches or would they be transferred elsewhere?

Answer: About 65 per cent of the cases would go from the "triage" centers back to their own companies. The other third would be evacuated to base hospitals.

Question: Would a man be reassigned from the combat duty to kitchen or something like that?

Answer: This was done in some instances. They would get a Certificate of Disability marked one, two, or three, i.e., they were to go back to duty, or duty behind the lines, or they would be discharged. A number of those men were assigned to some type of service behind the front line.

Question: There is probably no other field than that of psychoneurosis in which the racial characteristics present themselves more distinctly. Is that your impression also, so far as the war neuroses are concerned? For example, the symptoms of conversion hysteria, such as hysterical paralysis, contractures, fits, blindness, seem to be more frequent among Latins than among Anglo-Saxons.

Answer: Yes, I think that is perfectly true in civil life as well as in military life. I suppose that is why method of "suggestion armée" or "torpillage" was originated by the French, for it is a method of treatment particularly suitable for conversion hysteria. We see relatively few cases of conversion hysteria in our large out-patient clinics. I doubt if there are seen more than a few cases a month in all the clinics of Boston of real conversion hysteria, while in the French clinics, I am told, they are seen much more frequently.

Concluding, I wish to repeat that the individual who develops a war neurosis, the malingerer, the fellow who tries to bluff his way out of the Army, the psychopath, the unstable individual, will not be a good soldier. It is far better to have on the soldiering job a man physically sick than a neurotic. The Germans don't recognize the war neurosis as sufficient reason to get out of service. They are using the neurotic in building roads and front-line trenches, under strict military discipline, subjecting them to all the dangers of front-line activity. We have no way of knowing how efficient such military measures really are in treating a group of inadequate individuals whether they be malingerers or neurotics. We do know, however, that these individuals do not make good soldiers. They certainly represent a menace to any organization, and neither the British nor the American Armies will probably resort to such measures.

"SHELL SHOCK" AND EFFECTS OF HIGH EXPLOSIVES*

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THE term "shell shock" is rapidly becoming obsolete, though the clinical conditions it used to describe are by no means uncommon in the present war. Until I was asked to give this talk, I had not used the term for almost two years, following the findings of a British Commission which was set up in 1939, which recommended that the term would be dropped altogether. In the last World War millions of men in closely packed trenches were subjected to tremendous bombardments for months at a time. A mysterious kind of nervous disorganization occurred in those who were submitted to close shelling, and it was natural that this clinical syndrome should be thought to be due to the physical effects of explosion. It was difficult to deny some particular influence on the brain from the explosive force of the shell quite apart from direct injury to the brain from fragments. The nervous symptoms were often absent in those who had suffered severe direct brain injury. There began a search for some objective basis. Most of the patients suffering from shell shock did not come to autopsy. They were disabled for long periods of time, many of them with frank hysterical or neurotic symptoms, most of them labeled "chronic neurasthenia," some suffering from traumatic intellectual impairment, and some truly psychotic and requiring commitment. In the aftermath of the last World War thousands continued to attend special clinics and hospitals, receiving various degrees of pension for this disability, "shell shock." In the brains of the few who died without sign of external injury, pathologists reported finding in some no lesion of any kind and in others small petechial hemorrhages in the brain substance. It is now felt that such pathological changes as were reported were not necessarily present in those who survived and suffered from the clinical picture which was called "shell shock." Thus, in a case described by Mott, the man died from an explosion in a munitions factory but was known to have been exposed to carbon monoxide, which alone could account for petechial hemorrhages in the brain substance. Others may have suffered from fat embolism which also gives rise to such hemorrhages. At the time of the Spanish Civil War there came reports that bombing may cause death in a very mysterious way; tales of patients found dead after the bomb explosion who showed no sign of external injury and in whom at autopsy no cause of death was to be found. Again it was supposed that some mysterious effect of high explosives damaged the nervous system. One was naturally very skeptical of such reports, because in ordinary civil life dislocation of the cervical spine with transient compression of the spinal cord may cause death without more than a small softened segment. And so it is suspected that

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such dislocation may have caused these mysterious deaths in people who were killed by sudden explosive violence. Another rumor dating from the first World War was that if men were in a trench and a very high explosive shell fell near by, then in some way the ground was shaken and the people in the trench were concussed. It is difficult to find any adequate foundation for this, which is obviously related in some way to the problems of "shell shock" and unexplained death from bombing.

There are many points of resemblance between "shell shock" and "traumatic neurosis." As you know, many who have had a head injury in ordinary civilian life are particularly liable to nervous symptoms for a number of years afterwards. That condition has also led to differences of opinion. In its prolonged posttraumatic anxiety symptoms and variable association with actual cerebral damage, this syndrome is seen to be closely related to that of "shell shock."

I think some case histories will best give an idea of the nature of the problem. Most patients close to an explosion of bomb or shell suffer from direct wounds, such as foreign bodies in limbs, body, or skull, fractures of limbs, and injury to the chest. If one looks for what we call pure "shell shock," one must seek the patient who had no external injury from the explosion but who was unconscious. There are very few such patients, and their persisting symptoms are of emotional type. Many have had a definite but trivial injury, such as a cut scalp, and suffer later from the same symptoms.

CASE 1.—An infantryman, aged 29 years, had survived several severe bombings without any symptoms at all. On May 30, 1940, a shell dropped close to him in a trench. He estimated that he was about twelve feet away. He remembers a loud explosion, and then he remembers nothing more. His next memory was three or four hours later, and about a quarter of a mile behind the line where this explosion occurred. He was shaking all over, sweating profusely, and, in his own words, "crying like a baby." From that time onward his memory is clear. He thus had suffered an immediate amnesia of three to four hours without retrograde amnesia. He managed to get to a hospital. He had no sign of external injury anywhere, no cut of the scalp and no bruise; but he had a very severe headache, and he was kept in bed for some days. He was very sick and nervous. He slept very badly for the first few nights. Whenever he heard aircraft go past, he was overcome by general trembling, and from time to time he would break down in tears. His thoughts continually were about another soldier for whom he had a particular liking, who had been killed the day before his own incident. He continued to have early morning headaches. He was extremely unhappy. His eyes felt heavy. He continued to sleep badly, and he was still the same about six weeks later when I saw him. He had good intelligence, having reached top grade in primary school at the age of 14. He had had two years in an engineering firm, then joined the regular army, served in Egypt, enjoyed it, and left the regular Army as a reservist and worked in a brewery. He had been married for several years, had two children, and his domestic life was perfectly happy. There was no history of previous breakdown nor of nervous symptoms or epilepsy, nor was there any family history of fits or breakdown. He had never had any illness that he could remember. On examination he had no abnormal physical signs of any kind. X-ray examinations of the skull showed no signs of damage. The cerebrospinal fluid was perfectly normal in all respects. After discussion of his troubles, and particularly his anxieties about his friend who had been killed, he settled down rapidly, and within a fortnight was free from headache, and was cheerful and slept well, and after a month was sent on sick leave. The last we heard of him he was back on duty without symptoms. What was the cause of this

amnesia? Had he been concussed or had he suffered simply an hysterical episode? I have no doubt that he was thrown into an acute emotional reaction by the circumstances of this explosion. His anxiety about his friend possibly predisposed him to this. Are we to call that "shell shock" or not? Is that a mysterious organic reaction of the brain, or is it purely an emotional phenomenon?

CASE 2.—The next case was that of an infantry soldier who had been on guard duty when a bomb exploded some ten yards away from him. When he came to the hospital, he gave us a story that he had been unconscious for four days and had from that time onward suffered from severe headaches, from giddiness, whenever he ventured out of the hospital, and from inability to concentrate. He was at times depressed, and he did not sleep well. His personal history was a poor one. He had not attained beyond the third standard grade at school. He had tried all sorts of odd jobs until he had joined the Army, and he had a history of one brother who was committed. He had no history of previous breakdown. He showed no sign of damage to the nervous system or even to the scalp. X-ray examinations of his skull were perfectly normal. The only abnormality was an electroencephalogram which showed many slow waves of the kind found in psychopathic personality. Indeed, he was mildly psychopathic as well as backward. Mental status showed that his memory and judgment were particularly poor. Was this man concussed by the blast of the explosion, or was he suffering from an emotional nervous state like the first one? Eventually I interviewed another soldier who had been with him on guard at the time of the original bomb explosion. I told him I was rather interested to know about the "unconscious" condition of the patient during these supposed four days of unconsciousness, because we had no record from any hospital about this state. The friend said he had heard the patient shouting and ran to where he had been thrown into a heap of soft lime by the force of the explosion, and where he was shouting to be helped out. He was sufficiently conscious to be cursing the lime, knowing perfectly well what it was. It was then clear that this patient had not been really unconscious, and the loss of memory covered a period in which he had been extremely nervous and frightened of further bombings. That amnesia was not the amnesia of true concussion; it was amnesia of hysterical reaction.

These two patients are the only clear-cut examples of which I have kept a case record. But their story is enough to show what sort of reaction occurs in the patient who has not suffered external injury, but who is complaining of nervous symptoms following bombings. In strong contrast with these histories are two others characteristic also of close exposure to bomb and shell explosions but with penetration of the skull by fragments.

CASE 3.—A ground engineer was standing on an airdrome near a plane when an aerial bomb exploded ten yards away from him. He stood clinging onto the aircraft, which had caught fire, but he could not speak. He does not remember any pain at the time. He had multiple injuries to his limbs, which were bleeding, and in the course of a few minutes he collapsed, but he did not lose consciousness. He remained conscious but unable to speak until after he was admitted to the hospital about one-half hour later. About six hours later he was semiconscious and almost completely aphasic with a right facial weakness, but no weakness in the limbs. He had extensor plantar responses on both sides and strong neck rigidity. He could understand parts of your conversation with him and simple requests, but he was quite unable to make any reply. The cerebrospinal fluid was blood-stained, under a pressure of 190 mm. After a few more hours he was able to give his name, and the next day he was able to name a match box. He was unable to write his name and he had no apraxia. The cerebrospinal fluid pressure had now increased to 340 mm., and the fluid was still blood-stained. X-ray examinations showed small metallic fragments had entered through a very small opening in the skull and had traversed the ventricles to lodge in the region of the basal ganglia on the left side. They had crossed the cranial cavity, including the body of the ventricles. The scalp wounds received surgical treatment, but

the intracerebral fragments were not disturbed. In three more days he was able to give his name and age; he was a little confused, said the year was 1933, and a little later said the month was June, 1940, which was right. He showed little perseverance in speech. In the course of ten days his speech came back. His right plantar response remained extensor for a few days. His cerebrospinal fluid became yellow and clear within a week after the injury, and he was feeling well. There was a slight trace of right facial weakness in expression but no other sign. He remained well at the end of three weeks, and other wounds in his limbs had healed well. He was allowed a gradual convalescence and eventually went back to duty feeling fit. A letter from him after he went back to duty at an airdrome revealed that at first he did not feel sure of himself, but he soon overcame this.

This patient had been very close to a large explosion, and his symptoms, all except some slight loss of confidence on first return to duty, had all come from contusions by small penetrating fragments which had entered the brain causing aphasia. Any amnesia was exceedingly brief.

CASE 4.—A sergeant in an artillery regiment was in the Metz area of the Maginot Line on the last day of April, 1940, when a shell burst a few yards behind him, throwing him forward. He did not recall the noise of the explosion, but remembered raising himself up from the ground. This was at night. He seemed to see a moving cloud, and for a second he felt unable to move the right arm, where he had sustained a flesh wound; he also found he had been wounded in the left leg. He noticed the right occipital region was beginning to bleed. He walked unaided to a post about twenty yards away. In the post he could see the light of a lamp and no more. His wounds were dressed, and he was sent to a field ambulance unit. He had no headache and his speech was normal. The next day the occipital wound was excised, and a gap in the skull in the occipital region was found with brain protruding through. No exploration of brain was made. He remembers seeing a nurse's cap to the right side of him at this stage. He was transferred to another hospital. He was apathetic, he did not sleep well, and his head wound was bulging but was not infected. He was found to have a complete left hemianopsia. He was receiving sulfapyridine, his temperature was normal, and he could now see faces. On May 22 he could see well to the right but not to the left, and his sight improved gradually. He was reading normally three weeks after the injury. He had no hallucinations. He had a headache for five or ten minutes a day at first, but after three weeks he had none, and he was well except for his hemianopsia. This patient had a large bone fragment in the right occipital lobe. There was here nothing of the condition called "shell shock" in spite of his close relationship to a shell explosion.

Many other histories could be given of severe damage to the brain from close explosion without inducing the phenomenon of "shell shock." In one striking case, a soldier recovered fully with bomb fragments still in his brain, and only after an interval of some two months, under the combined stress of domestic worry and further bombing, he began to complain of the headaches, giddiness, inability to concentrate, and insomnia characteristic of the condition. If we turn to cases of nervous reaction with doubtful head injury from causes other than explosion, we find also that the persisting nervous or emotional reaction bears no relation to the structural damage caused by the injury.

Case histories of patients suffering from "traumatic neurosis" following closed head injuries of other kinds were then given. The development of the posttraumatic syndrome of headache and emotional instability was considered to be related either to reduced intellectual capacity due to the injury, or to constitutional predisposition to neurosis. The symptoms in no way differ from those suffering from the effects of bombing. Returning to the condition called "shell shock," we may see in it an emotional reaction to the catastrophe of the

explosion. If actual brain injury has occurred, the syndrome may also appear, and then may be determined in part by the residual cerebral damage. It must not be forgotten that an emotional reaction can occur on a basis of real reduction of intellectual capacity. But the most characteristic case of "shell shock" has no history of direct damage to the brain and no evidence of reduction of intellectual capacity. The condition is essentially one of anxiety neurosis and is best labeled so. The very name "shell shock" predisposes either to self-pity or to self-glorification in the soldier and is a potent factor in perpetuating the condition. The greatest advance in the subject is the abolition of its old name.

The amnesias following bombing are usually patently of hysterical kind. The frequent absence of true concussion leads to investigation of the nature of the amnesia. Experiments were cited to show that true concussion is a traumatic paralysis of nervous tissue caused by acceleration. The change in motion of the head striking a heavy blunt object, or being struck by such an object, is very abrupt. Small penetrating fragments of bombs or shells do not impart such acceleration to the head as a whole and therefore cause little or no concussion. Similarly, the air-borne force of an explosion, though very brief, does not accelerate the head quite as rapidly as a solid mass does, and so does not concuss.

The violence of the displacement of the body and head by an explosion may cause concussion by flinging the patient against some solid object, but there is nothing mysterious or unusual in that. Secondary injuries of skull and spine are common, and fat embolism of the brain from broken bones sometimes occurs. The causes of death from bombing injuries to the nervous system are often complicated. Thus, people may be truly concussed by secondary injuries, and in any case are likely to suffer from the emotional disturbance that we call traumatic anxiety state, traumatic neurosis, or simply anxiety neurosis. Such a psychoneurosis persists usually only in persons with psychoneurotic constitutional liability. It is necessary to assess the nature of the original injury and the degree of intellectual impairment persisting if organic damage to the brain is to be determined accurately. It is naturally of great assistance to have a good record of the original injury. Physicians and surgeons who attend the patient at the time of injury usually lack time to make accurate notes, but any account of the patient's condition when he is first seen is of great assistance afterwards. Amytal is often of assistance in unraveling hysterical amnesias.

With regard to treatment, I might say that most cases of emotional disorder will make a good recovery with persuasion, discussion, and suggestion. In many, some abreaction is essential. In severe cases, usually with bad personal previous history, an extensive investigation of their childhood anxieties is necessary, and in this type of case it is very difficult to get them back to duty involving explosions and bombing again. From the military point of view, the patients who are likely to get back to duty usually do so after quite simple treatment, provided their trouble is understood, provided there is time to go into their story and get down to the nature of their anxieties. They do not react well to faradic or simple suggestion.

Question: What is considered to be the pathology of a concussion? I was taught that in concussion there was some shaking up of the neurons, perhaps some disturbance in the microscopic structure of cells reversible in nature, so that by the time they got to post mortem nothing could be found.

Answer: Most people like to picture some histological change in their minds when they think of concussion. But there is no known histological change. That does not mean that it does not exist, but rather we prefer to describe it as a disturbance in function. Concussion is traumatic paralysis. It is rapidly reversible. It is unlikely that any stain will show such a rapidly reversible change in nerve cells.

Question: Is the incidence of shell shock as great in this conflagration as it was in the last—1914-1918?

Answer: It is very difficult to get any statistical evidence. For one thing, it is listed under anxiety state or traumatic neurosis or brain injury (when such exists). Patients are scattered in numbers of hospitals so that few see many together at any one time, but I should say my impression is that it is just as common as it was in the last war. On the other hand, I am satisfied that the avoidance of the name of "shell shock" and the treatment of the condition as a neurosis has resulted in the reduction of the number of cases with persistent disability to a very small number.

Question: It seems to me that it would be quite difficult in your treatment to gauge how quickly the patients should go back to duty, because if it is a case of concussion, they are liable to need a very prolonged rest before they take up their duty, whereas if it is not a concussion but due to neurotic features, they would get back to duty rather quickly. Is not that a difficult point to decide?

Answer: Yes it is, because it is impossible to lay down a hard-and-fast rule. Each case has to be judged on its own merits. When the patient starts getting up and having headaches, it has to be decided then whether he is attempting too much after a real brain injury, or whether he is becoming nervous. The most important single index of severity of brain injury is the duration of the true amnesia. If retrograde amnesia occurred, the posttraumatic amnesia was a true concussion.

Question: Do you think it is possible to pick a soldier who is not going to have a traumatic neurosis?

Answer: Of all patients who are still suffering from traumatic neurosis more than six weeks after they are injured, the number who have a bad family history or previous history is very high. The proportion with abnormal electroencephalograms is also very high, but they are not always the same group. Some have normal encephalogram and poor family history, and vice versa. Some have neither abnormality. It is unknown how many with equally bad histories fail to become casualties in spite of abnormal stress. That would be an important subject for study.

ALCOHOLISM IN MILITARY SERVICE

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ALCOHOLISM and drug addiction among men in military service are usually concealed and thus are subjects one can approach only indirectly. A direct approach to them is doubly difficult, because it requires consideration of the whole personality of the men in service. Two contrasting extremes come to my mind when I think of the alcohol addict or the drug addict in military service. First is the picture one sees when the band begins to play and the regiment is out on dress parade. No one would think to see the stalwarts marching past the grandstand that there could be one drunkard in the entire outfit. The other picture is the one that the psychiatrist sees years later in the hospitals of the Veterans' Administration. As you know, many patients are admitted there on account of alcoholism or drug addiction. Somewhere between the parade ground and the Veterans' Hospital, alcoholism and drug addiction become a problem.

A considerable number of the patients admitted to Veterans' Hospitals are ex-service men whose illness has been diagnosed *alcoholic psychosis.* A smaller number of men are given either the diagnosis *psychosis due to drugs and other exogenous toxins* or *without psychosis, drug addiction.* The early stages of these conditions may not be obvious when men are in camp or on maneuvers, nor are they a prominent feature among the neuropsychiatric conditions encountered in actual combat. But, when the war is over and men are depending on their service record for hospitalization, a substantial number of cases of alcoholism or drug addiction will crop up expecting care for the rest of their lives. How did these men get into the service, assuming that they brought their problems with them, or how did their problems develop in service? How is it legally possible for them to claim service conditioning or service precipitation of their difficulties that arose afterwards?

First, one may consider the men who are already addicted to the excessive use of alcohol or drugs *before* they enter the Army. In the first World War men were taken into military service very rapidly. If they had a neuropsychiatric examination, it was often rather sketchy. Some might say that is still true. But neuropsychiatric entrance examinations are more complete today than they were twenty-five years ago, although sometimes a neuropsychiatrist still has only a very few hours in which to examine twenty or thirty applicants for military service. In doing this work, anyone can make a mistake, and when one is in a hurry, it is easier than usual. To prevent this, the time allowed for the examination of each case should be longer, and the form of the examination should be amplified.

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Even though the examination may comply with the strict limits of the military forms that are filled out, it is still possible for a good many alcoholics to get into military service. There is no exact way of preventing this at the present time. Theoretically, the alcoholic is not good material, but occasionally one makes an adequate soldier. But too many alcoholics are not good for the Army, the General Grant tradition to the contrary notwithstanding. I wish someone would decide whether or not the Army is good for the alcoholic. It may be possible that some of the factors which have precipitated alcoholism in an individual case may be alleviated by military life. On the other hand, military routine may aggravate the alcoholic tendencies of some individuals. The Army, of course, is primarily a functioning defensive or offensive unit, and hence can concern itself only secondarily (if at all) with the therapeutic advantages of Army life for the individual. But, since the Army is made up of groups of individuals, their welfare in Army life becomes an essential part of the mechanics of the Army. The benefits a man gets from Army life depend on his own personality, the nature of his work, the way he is handled by his superior officers, and the vicissitudes of military life.

Today when men are being examined for the Army, there is a careful checking of outside sources in an effort to obtain some information about the man's personality and habits. The problem still remains, "How can the alcoholics be excluded from service?" In some cases a careful neurological or psychiatric examination gives little evidence of latent alcoholism, because if the alcoholic individual eats and exercises adequately, he may not show the physical effects of heavy drinking. Even if the examining officers communicate with the parents, the teacher, the minister, or the postmaster, a prejudiced opinion may be returned in favor of the man, especially if the family wants to get rid of him, or if he wants very much to get in the Army and they feel that enlisting is the only way out or is the best way to save his face in the community. These attitudes aggravate the situation and work to the detriment of the government. Many people tend to feel that if a man does not fit in anywhere else, he can enlist in the Marine Corps or go into the Army or the Navy, and that then he will be Uncle Sam's problem. Certainly he will then no longer be the problem of his own family or the out-patient clinic or the social service department of a hospital. People have come to me as a private physician to ask me to give favorable recommendations to selective service boards concerning ne'er-do-wells, latent or patent alcoholics, and various types of psychopaths who, in all probability, would adjust themselves no better in the Army than they have done in civilian life. I am sure that many other physicians in the United States have had similar requests. The public must learn that the qualifications for success in the Army are essentially the same as those in any other profession. Stable and mature persons are needed. It may be a fact that during the Napoleonic wars just anybody was good enough for the Army and was welcomed there, the fellow who got a girl in trouble and had to leave town, the poacher avoiding jail, and the criminal who did not dare show up again at home. Those men made a motley gang that was good enough for Boney, but that is no longer true today. Our Army is reorganized. It is streamlined. It is scientific, and it is psychological. *It wants and it must have the best.* A military life is not good shotgun

therapy, and the Army, Navy, and Marines do not want psychopaths, alcoholics, and neurotics, or persons with behavior difficulties. It is going to take some time before these points can be made clear to the public, but if that can be done, and if the present standards of admission can be rigidly enforced, twenty years from now there may be fewer derelicts suffering from the end results of chronic alcoholism and drug addiction in the Veterans' Hospitals of 1962.

When I speak of alcoholism in the service, I do not mean the kind of drinking seen when the American Legion is in town. That is something different. I would distinguish that as being a healthy kind of "blowing off steam," something that does not occur very often. In fact, it occurs only during the Legion Conventions. I realize that when the Legionnaires meet annually their emotions are very strongly stirred by convening and the recollection of old times. Generally speaking, the Legionnaires are not the type one would define as alcoholic.

The alcoholic has been variously described as a man who cannot get along with liquor and who cannot get along without it, or, he is a man who lets liquor run him rather than controlling his liquor. The alcoholic is a person in whom alcohol acts as a poison; he does not react to alcohol (physiologically) as a normal man reacts. He is a person who drinks to a degree that interferes with his work and home life. A final definition of an alcoholic is one who cannot stop drinking. These are all practical definitions; they are not scientific, but a jury would know what is meant by them and would understand the thread of common meaning that connects them all. We must use such definitions as these until more basically scientific facts are discovered. If an underlying basis for a definition can be found, it will probably contain some of these central ideas.

The problem of alcoholic addiction in military life is a good deal like the problem of alcoholism in business. If you ask a business man if alcoholism is a problem in his firm, he will say, "Certainly not. As soon as a man starts to drink, we fire him." But, if you say, "How many men have you fired during the last ten years for alcoholism?" he may be able to locate in his records a fairly large number.

In general, when alcoholism occurs in the Army, the drunk gets put into the guardhouse and is punished or discharged. The handling of him depends on the way the men live and on his rank, as well as upon other personal factors. If an officer becomes alcoholic, usually his friends take care of him, or he may be put at a post where he is not too important. Or he may not be advanced, or he may be retired prematurely. This occurs through the internal mechanics of military administration. In some instances, however, when alcoholism is acute, the individual is put into a hospital for observation and treatment. Alcoholism is accepted as one of the drawbacks inevitable in an imperfect world. However, some consider that excessive drinking in the ranks is an index of poor material or low morale, and that the best possible way to prevent poor material from getting into the service is by rigid entrance examinations and by scrupulous following up of the qualifications for admission to service that are already in operation. This applies to officers as well as to enlisted men.

Excessive drinking among enlisted men creates several difficult problems. These problems are not simply administrative or merely medical, they are basically psychiatric in their nature. Recently, I heard an officer discussing this

matter. He said, "Yes, heavy drinking among soldiers is a problem, particularly when you have large numbers of men who are not actively occupied most of the time. Under certain unfavorable conditions, it can become serious, but a lot can be done in a constructive way to control it. Where there are few troops it is usually not much of a problem. In general, it can best be handled in the following manner: First of all, military police are put on and the penalties for drunkenness are increased. Second, arrangements are made to give the enlisted men the use of facilities for recreation and diversion, such as swimming pools, tennis courts, bowling alleys, etc., through clubs and social groups; and dances, parties, and picnics are planned. We found that the more we saw to it that the fellows had a fairly good time, the less difficulty they had with the sort of desperate and destructive drinking that military men sometimes go in for." He added, "It ended with our enlisted personnel having better opportunities for recreation than the officers had, but the officers didn't object, because they thought the results were worth it. On the whole, it was a very good solution. Of course, it would be different under conditions of actual warfare."

Other officers who are familiar with disciplinary and recreational problems in military service corroborate this point of view.

In general, the men who cannot adjust themselves in military life and who succumb to excessive drinking are probably the same kind of inadequate individuals for whom some assistance and supervision have to be devised in civil life. And often the type of help needed by inadequate and alcoholic individuals in their efforts toward emotional and social adjustments are more than the ordinary civilian or military community alone can afford.

In the first World War these problems were beginning to be recognized. Now recognition is more widespread, and more of an attempt is being made to deal with them today than was made in 1917. The first emphasis is now being put on preventive measures. Yet, a satisfactory approach to these issues remains a partially unsolved problem in military life. When the first World War began, in April, 1917, there was no question about where things were heading. There had to be an all-out preparation for action, and the nation fell into a frenzy of the most patriotic and strenuous military effort this country had ever known. After a relatively short period of training, men were shipped immediately abroad and action was quickly forthcoming. All was excitement and activity. The problem of undrained emotional energy among the troops was not so severe as it has been until the declaration of the present war. Now we are really in a shooting war with a large and growing Army. The general staff is so busy equipping and training men at this moment that it cannot be expected to look after the individual emotional problems of service men. At the moment, this is a civil problem and has to be handled by communities, not only through the U.S.O., but through every community organization. Great progress has been made in the last six months along these lines. Until war has been actually declared, in some communities men in uniform are discounted socially. After the declaration of war, however, their stock goes up as war tension rises and the public begins to appreciate soldiers and sailors. Civilians in any community, with relatively slight effort, can do a great deal to turn the interest

of enlisted men *away* from the inadequate and destructive types of amusement and drinking that men in uniform sometimes fall into when they are on leave or liberty. Until such effort is made by civilians and community organizations to provide normal entertainment, excessive social drinking is apt to continue. The alcohol problem in military service is essentially an emotional or personality problem, just as it is in the civilian life, though it is also directly related to the release of unspent energy, in recreations and diversions carried out by individuals or groups in sports, games, dancing, and all social activities. Although social measures do not get at the roots of the alcohol problem, I believe that 95 per cent of the men who drink too much while on leave, for example, would accept nonalcoholic entertainment just as easily. For that matter, alcoholic entertainment (in moderation) in a wholesome setting would be much better for them than drinking alone. Not alcohol, but the intemperate use of alcohol, is the problem in the army as well as in civilian life. People have asked whether or not beer should be sold near military posts. I, for one, think emphatically that beer should be sold and that drinking in moderation should be encouraged. Recreational facilities of all sorts are essential to men undergoing the strain of preparation for military life. Of course, someone will point out that this brings up the sex problem, but the United States Public Health Service is learning how to handle this quite adequately. In spite of progress, we shall always have with us the sporadic critic or the fanatic who will complain if a soldier off duty has a ten-cent beer or puts a nickel in a juke box.

One of the most important aspects of Army life is the relationship between the officers and men. I believe that one of the most effective approaches which a professional man can make to any situation is the psychotherapeutic or melioristic approach. This can be used whether one is a doctor, a lawyer, or an officer. This approach aims at establishing confidence between individuals and encourages the best possible outcome of the situation. This point of view is well-known to physicians in their work with neurotic and psychotic individuals. It has found a concrete expression in the mental hygiene movement, which consolidates the psychological findings of psychiatrists, physicians, social workers, and lawyers. This information is now available in a form that can be applied in the home, the school, and the community. There is no reason why some of the basic principles of mental hygiene should not also be applied in military life. Men learn a great deal from military service that they could not learn at home or in school or in the community where they have lived. A military program can and should include constructive outlets for the energy of the soldiers to balance the necessarily destructive aims of warfare. There is no reason why along with their other duties officers should not understand and use the principles of mental hygiene in their work. Essentially that is exactly what a good officer does. If a soldier looks back through his military experience, he will remember some officers who were outstandingly capable, constructive, realistic, and fair, and were a good influence generally on the men under them. In military life, as in civilian life, the influence of the superior personality is a very powerful force in molding morale and directing policy.

The problem of draining emotional energy for many soldiers is not completely taken care of by physical work and military drill. There are a great

many men who drill all day, fall out, turn in, and that is all there is to it. But there are also in service men who have a superabundance of energy. Work does not exhaust them. Furthermore, there is a mischievous type, who seems compelled to go out and have some adventure once in a while, to get into trouble or get drunk, or do something exciting. Even he is not basically the alcoholic type. The soldier who occasionally gets drunk and gets over it is not the one I mean when I speak of the alcoholic.

I believe the alcoholic is distinctly a sick person, a man with a sick or abnormal personality. His personality is far more unstable and more immature than the average. He stands out as distinctly different from his fellows. He may be the kind of maladjusted service man who is chronically complaining, who tends to blame others, who "can't take it," and he may show what the psychiatrist calls "paranoid tendencies." There are a few crazy people in the Army who get along perfectly well. They fight and go through campaigns; occasionally one may become a hero. But there is also the kind of person who never gets along anywhere very well. We have to fall back on that overworked word *psychopath* to describe him. The alcoholic and the drug addict are recruited from the ranks of the psychopaths. We have said that alcoholism is an illness; it may also be considered the symptom of an illness. By that I mean that alcoholism is a disturbance, a smoke screen, covering an underlying personality disturbance. To call it a disease is merely a simple way to acquaint people with the fact that we realize the alcoholic is a sick person.

If you study an individual alcoholic, it will be apparent his symptoms go back to his early life. I should like to tell you about one patient with whose case I am familiar. He is a man who has been committed now for about twelve years to a Veterans' Hospital. I am using his case as an example, because it illustrates several important points. The patient is now 49 years old. First his illness was diagnosed *alcoholic psychosis,* but after he had been in the hospital for a few years the diagnosis was changed to *dementia praecox, paranoid type.* He was born in New England and was an only child, whose father died when he was four. He graduated from college with high marks and was engaged once, but his fiancée jilted him. He served abroad with the Army of Occupation. He always drank a great deal and became drunk frequently, but he managed to get by because his friends covered up for him very well. He was known to have drunk to excess on several occasions before he was discharged. Once he was called before a neuropsychiatric examining board (shortly before his discharge), at which time a psychiatrist saw him and made a note in his record that the patient had a psychopathic personality with paranoid tendencies. After discharge from the Army he went back to work but did not get along very well. He began to drink excessively and got into several brawls. About 1925 he began to develop the idea that he had invented an electric machine that would do anything. Then he began to feel that people were trying to steal it and that he was being persecuted. Following this, he was committed to a private hospital for a period of study. At this time, the clinical picture was complicated by his drinking and by neuritis and other symptoms due to drugs he had been taking. This cleared up and he was released. Later he got into the same kind of trouble

again, and this time was committed to the Veterans' Hospital. When I spoke with his mother about him, she said that he was very sensitive as a little boy. He was overidealistic, perfectionistic, and he did not get along well with children his own age. He did get along very well with older people. She said he was always timid and that he was afraid of men, and he was also very reserved with girls. She could not get him to go to dancing school. He had a good deal of trouble with bed-wetting until he was 8 years old, and after that masturbation was a severe problem. Once she took him to see a child psychologist on that account. When he went to college, the school authorities reported that he was one of the men who was always drunk at any dance or social gathering. He would often get so drunk before a party that he would not even get to it. He would occasionally take a girl to a dance, where he would get drunk or start a fight, and somebody else would have to take the girl home. He was seclusive and not very popular socially. Out of a class of 100 men, he had only one close friend, who also drank heavily. His military service record was not remarkable. After the war he developed a frank psychosis.

I have taken as an illustration a man who started out with alcoholism and developed a definite psychosis. Looking back, I do not think anyone at the beginning could have said that this man was normal or that he was well. He was a problem child, a difficult adolescent with many neurotic traits, and probably had a deep-seated neurosis, which slowly developed, with social deterioration, finally resulting in the complete breakdown of the individual. Whether alcohol was the cause of the breakdown we do not know, but it was an important precipitating factor. Alcoholism combined with paranoia is usually a precursor of permanent mental illness, as turned out to be the case in this instance. This man has not responded to any of the efforts made to treat him. He turns his back on anyone who comes near him. He never speaks but just closes his mouth and sits. Occasionally he is violent and combative.

The results of attempts to treat the chronic alcoholic addict have not been very encouraging. The different forms of shock treatment have been tried without much effect. It is very difficult to say just what the alcoholic is or how he can best be approached for treatment. Usually the alcoholic individual may be classified with the psychopathic or the borderline group, though in some instances excessive drinking is a symptom of an actual psychosis. Many alcoholics for a long time appear to be neurotic individuals going through severe conflicts. They drink to escape their conflicts and the resultant nervous tension.

When a man drinks, the physiological and pharmacological effects of alcohol are very definite. First, alcohol enters the blood stream very rapidly through the stomach wall. Some of the alcohol is stored in the liver. It is believed that this fact may partially explain why some people can hold their liquor and others cannot. Tolerance may be an expression of liver function. For many years, Dr. Timothy Leary, at the Boston City Hospital, has studied cirrhosis of the liver in cases of chronic alcoholism, where it is a very common finding. He reports that the subject needs further study. One confusing point is that cirrhosis of the liver is sometimes found in persons who have never touched alcohol.

Next, alcohol passes into the spinal fluid by which it comes directly in contact with the nerve cells. Once it was believed that a man who had a certain

amount of alcohol in his blood was drunk, and if he had more, he was more drunk. This, of course, is true within general limits, but more careful study of alcoholic individuals has recently shown that one can take a drink and begin to get "tight" at a certain blood alcohol level. Then, when the blood alcohol level, after further drinking, rises, instead of getting more drunk, the individual seems to adjust himself to it mentally and may appear more sober. These observations need to be explained. Learning phenomena is not sufficient; there may be something more, something physiological to this reaction. These findings may limit the value that up to now has been found in "drunk meters" and alcohol breath tests, but this should not entirely destroy their use. Legally, blood and breath alcohol tests are still valid, subject to interpretations, and they are far better than nothing.

Different tissues, such as muscle and brain, apparently oxidize alcohol at slightly different rates. For example, a laborer may get over a drunk quicker than a brain worker, because he may burn it up in physical exercise out-of-doors. Furthermore, the oxidation rate of alcohol in the body may be somewhat altered by certain drugs, for example, dinitrophenol derivatives, and possibly benzedrine, though the evidence is not final. It is possible that some day a drug may be found that will alter the oxidation rate of alcohol in the human body in a way that may be therapeutically useful, though at present the available drugs are too toxic for therapeutic use. The factors that influence the lowering of the blood and spinal fluid alcohol content are all-important physiologically and need to be studied much more intensively. Generally speaking, the blood alcohol level in an individual is the result of two factors, the amount of alcohol taken in and the body weight, since alcohol is dissolved in all body tissues about equally. For example, if you take two men, one who weighs 250 lbs. and another who weighs 125 lbs., and give them the same amount of alcohol, the man who weighs 125 lbs. will have a blood alcohol level about twice as high as that of the man who weighs 250 lbs.

The next point to mention, when speaking about the effects of alcohol, is this: There is no evidence that alcohol increases human efficiency, except possibly momentarily. As the blood alcohol level rises, efficiency of the nervous system and performance gradually are reduced. From elation, drinking can lead to coma. Although we speak of getting "tight," we really get "loose" when we drink, because the basic action of alcohol as a narcotic drug is to depress the higher centers and release the inhibitions. There is a vast amount of misinformation about that one point. Forty or fifty years ago, physicians were taught that alcohol was a stimulant, and it is often listed among stimulants in old textbooks. Actually, alcohol acts as a depressant in its effect on the nervous system; the only stimulation alcohol affords is to the taste buds of the tongue and the mucous membrane of the throat.

From the point of view of military efficiency, this is significant. Many years ago alcohol had a very important part in the military diet. It has been served as grog in the Navy. Rum rations were given to Continental soldiers. Sam Houston is said to have fought most of his Mexican campaign on rum, and at the Battle of New Orleans it is said that Andrew Jackson was so weak (after a

strenuous march) he had to be helped up on his horse at first, and that before he could lead his men, his attendants gave him a mug of whiskey to drink. But the best information about the modern Army is that alcoohl plays no official role in warfare and is excluded from actual maneuvers. It has been reported, for instance, that the Nazi troops in active campaigning are not allowed any alcoholic liquor in any form, and that the picked troops who invaded France in May of 1940 were, for the most part, men who had been on a military training regime more strict than that of any football teams in our better universities. If this is true, it may be very significant. It may mean for all armies now that under serious military conditions the amount of drinking that is permitted may be greatly restricted or practically nil.

In summary, however, man's nature is not apt to be basically changed, even by warfare. In whatever form alcohol may be provided or available as a beverage, and whatever its effect may be, considered from the realistic point of view, it is present and is accepted as a part of life, along with food and drink, and the fact remains that for the great majority of the civil and the military population, alcohol does not constitute a problem of serious importance. The individual with alcoholic tendencies is the exception rather than the rule. What is important, however, is that drinking in moderation be encouraged or emphasized. Personal repressive and restrictive measures are basically of little use, since they fail to get at the roots of the problem. It is also important that reasonable and wholesome facilities for relaxation and recreation be provided men in military life. And, what is most important, that further effort be made to discover and understand the type of individual who is inadequate, who tends to drink to excess in the escapist, addictive, or destructive patterns, and to keep him out of the armed forces of the nation. He will still exist, of course, and will still remain a problem for the community to deal with, but his future is not as hopeless as it once was now that physicians are more clearly realizing that the alcoholic is a sick person and that he was sick *before* he began to drink, and that he is sick between bouts when he is *not drinking*. His illness can be further defined as a deep-seated disturbance in his personality, a long-standing difficulty, a maladjustment in his emotional or in his social life, sometimes the expression of an inner problem, or sometimes the result of an external situation in his life. In this sense, alcoholism can be regarded as a symptom, or as a smoke screen, for that is what it always turns out to be, when the individual is studied and an effort is made to treat him. About this basic disturbance of which alcoholism is the symptom, physicians know as little today as was known about diabetes forty years ago. By analogy, it is as important to keep out alcoholics of the armed forces, generally speaking, as it is to keep out diabetics. That is what physicians and neuropsychiatrists at the present time are trying to do. To some extent they are successful at this task, and to the extent that they are, there will be just that many *less* alcoholic derelicts and drug addicts to be cared for in government hospitals in the future. The men who are excluded, however, will probably remain in the community and will probably continue on a destructive or disintegrative path, as disturbed individuals without treatment usually do, but even there they are not being ignored. An effort is now being made in some

communities to study and treat these individuals with the aim of preventing alcoholism. This effort is based on the idea that they are sick, and that their sickness is accessible by three well-known avenues: chemical, psychological, and social. It is believed by those who are carrying on this work that the methods of science and a modern progressive and humanistic approach will not fail in time to produce worth-while results in terms of more satisfaction and usefulness for the alcoholic, and the reduction of unnecessary psychic suffering on the part of the alcoholic individual and those who are dependent on him.

AN ACUTE RESPIRATORY INFECTION RESEMBLING SO-CALLED ACUTE PNEUMONITIS*

A Report of 40 Cases

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DURING the months of June, July, and August of 1941, the department of medicine at the United States Naval Hospital, Corpus Christi, Tex., observed an acute infectious disease of the respiratory tract with unusual pathological changes in the lung.

There were 112 admissions with acute respiratory infections during this period, and the present study is based on 40 cases with the above unusual lung findings. These patients were young adult members of the United States naval military service and were between the ages of 17 and 26 years.

Cases which apparently simulate these have been reported during the past several years in the United States and foreign countries, e.g., England, France, Hawaii, and Spain.

The disease differs from the familiar forms of lobar pneumonia caused by pneumococci and from the usual types of bronchopneumonia caused by hemolytic streptococci, staphylococci, and other organisms. In the majority of the cases reported the course of the infection is characterized by an insidious onset with minimal respiratory and mild constitutional symptoms. At the onset there are no definite abnormal physical signs and the leucocyte count is normal or only slightly elevated. Within 48 hours a roentgenogram of the chest shows a small area of pulmonary consolidation usually located at the base of one lung.

This disease has been described by a variety of names, e.g., as acute influenzal pneumonitis,[3] acute pneumonitis,[1] atypical pneumonia,[5] acute interstitial pneumonitis, atypical bronchopneumonia,[11] peribronchial pneumonitis,[9] and adolescent pneumonia.[6]

In 1934 Gallagher reported a series of 16 cases with what he termed adolescent pneumonia and which had many characteristics very similar to this clinical picture. Bowen, however, was apparently the first to suggest that this infection might be a new disease entity when, in 1935, he described an outbreak

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occurring among Army troops stationed in Hawaii. In 1936 Allen, at Fort Sam Houston, Tex., reported a series of 50 cases with acute pneumonitis. In 1937 Scadding, in England, reported a group which he called disseminated focal pneumonia. In 1938, 1939, and 1940, sporadic cases and minor epidemics were reported in the United States and England. These outbreaks were widely scattered in this country, with isolated cases and minor epidemics being reported in Pennsylvania, Oregon, Texas, New York, Minnesota, Ohio, Delaware, Maryland, California, and Massachusetts. In 1941 small epidemics were reported from widely separated points in Texas and Oklahoma.

The majority of these reports describe cases very similar to those we have observed in our series. However, those described independently by Cass in 1936 and Reimann in 1938 had more marked constitutional symptoms than those we have seen. Also the series reported by Reimann and Haven in 1939 differed in that those cases associated with abnormal pulmonary changes had severe constitutional symptoms and those having mild symptoms similar to our cases had inflammatory changes in the upper respiratory tract. Symptoms due primarily to inflammation in the upper respiratory tract were not an important or frequent finding in our cases or in the majority of those reported by other workers.

At the present time there is considerable speculation as to whether these cases represent a separate disease entity caused by some type of filtrable virus or are simply atypical bronchopneumonias caused by one of the usual types of bacterial organisms. Since these cases occur largely in previously healthy young adults, Lyght and Cole have questioned not only that this infection is typical for this age group and type of individual, but also that it is a new or separate disease entity. They call attention to the fact that the concept of pneumonia, as a disease entity, can no longer be restricted to a well-defined clinical picture because both the nature and severity of the infection are subject to too many variables. It was their opinion that the concept of pneumonia should be broadened to include the type of case under discussion.

Although the etiology of this disease is still in doubt, the prevailing opinion seems to be that it is caused by some type of filtrable virus. There is some evidence to support this view as shown by the following, e.g.:

1. The contagiousness of the disease.
2. The inability to demonstrate reactions associated with any known pathogenic bacteria either by culture of the sputum and blood or by other laboratory procedures.
3. Failure of the infection to respond favorably to sulfonamide chemotherapy.
4. Work of Horsfall and Weir and Stokes and Francis with recovery of a virus and production of pulmonary consolidation in animals.

Stokes and Francis obtained an unusual virus from the nasopharyngeal washings of one of Reimann's patients and from the blood of another. It was virulent for mice and caused pneumonia and encephalitis about 2 weeks after inoculation. However, they were unable to do serological tests because of the loss of the agent and, therefore, were unable to establish a causative relationship.

Although Horsfall and Weir were not able to infect a variety of animals by intranasal inoculation with throat washings from a number of clinically typical cases, they were successful in transmitting the infection to the wild mongoose. They succeeded in recovering a virus which on inoculation pro-

duced pulmonary consolidation in the animal. Healthy mongooses placed in contact with infected mongooses developed pulmonary consolidation. The virus was neutralized by the serum of mongooses convalescent from the infection but was not neutralized by normal mongoose serum. Serum of human beings convalescent from acute pneumonitis also neutralized the virus, but serum obtained from the same persons during the acute phase of the disease failed to do so. The virus was filtrable through Berkefeld V. and N. Candles, was not inactivated by glycerin or freezing and drying in vacuum, and was propagated for at least 30 serial passages on the chorio-allantoic membrane of the developing chick embryo. It was the opinion of the authors that virus is the cause of so-called acute pneumonitis in human beings.

Enders, Sullivan, Hammon, and Meakins of the Department of Bacteriology, Harvard Medical School, attempted to demonstrate an etiologic agent by the inoculation of mice, rabbits, guinea pigs, ferrets and macao mulatta with blood, sputum, and nasopharyngeal washings from 11 patients in Murray's series of cases, but were unable to produce any recognizable pathologic changes in any of the animals.

The pathology of this disease is limited to the findings in one fatal case which occurred in Kneeland and Smetana's series at the Presbyterian Hospital, New York City. The microscopic features of the pneumonia were characterized by a mononuclear cell exudate in the pulmonary alveoli and an acute pulmonary vasculitis. However, none of our cases are comparable to their group of severe infections in which the death occurred, and therefore, any conclusions drawn regarding similar pathologic changes in our series of cases are likely not to be accurate.

Most of the reports of this disease have been made as a result of the study of outbreaks occurring among young adults living either in colleges or quartered with military troop concentrations. In these two groups a substantial number of cases have occurred over relatively short periods of time, and therefore, the disease has been thought to be readily transmissible. Although our report represents a similar situation, we were unable to find that the disease was any more prevalent among the men living in barracks with possible contacts than in those who were unexposed.

The disease occurred in about the same ratio in aviation cadets, was of about the same severity, and ran a similar clinical course. Enlisted men living at outlying auxiliary fields acquired the infection, but these cases were rare. Although we were unable to trace exposure or contacts of sufficient number to determine the definite degree of contagiousness, it was our opinion that it was probably transmitted from one person to another by casual contact.

There was no evidence to indicate that lack of physical fitness, previous upper respiratory infections, abnormal exposure, physical fatigue and climatic conditions were predisposing factors.

CLINICAL DATA

The average typical case began as a simple acute infection with minimal respiratory symptoms. Usually for a day or two preceding admission, the patient had not felt well. Following this, he developed a moderately severe

frontal headache, backache, pains in legs, weakness, unproductive cough, and fever (100°-102°). In the large majority of instances, these patients were considered only moderately ill.

On admission, physical signs were minimal or entirely absent. Usually there was slight redness and injection of the pharynx, and an elevated temperature. The pulse was either normal, or the pulse-temperature ratio showed a relative bradycardia. The respiratory rate was normal. There were no abnormal physical signs on examination of the chest. The leucocyte count was normal or slightly elevated with the percentage of polymorphonuclear cells either normal or slightly increased.

The diagnosis was usually made on the third to fifth day when roentgenogram of the chest was made and a small abnormal area of moderate density was found in one lung field. A day or two later crepitant râles could be heard at the base of one lung, posteriorly. Usually there were no physical signs indicating pulmonary consolidation. The cough continued and by then the patient had begun to expectorate a small amount of mucopurulent sputum. The temperature returned to normal in about 6 to 8 days. Defervescence was by slow lysis. By this time medium moist râles could be heard at the base of one lung and usually persisted for 7 to 10 days. The patient remained in the hospital another week or two and was returned to duty well.

ANALYSIS OF SIGNS AND SYMPTOMS

Approximately one-fourth of our cases had a relatively sudden onset, under 24 hours. Only one-sixth had a previous history of an upper respiratory infection, such as colds and sore throats, during the 3 weeks preceding the onset. Approximately one-third had typical nasal symptoms of an acute rhinitis at the onset of the infection; one-fourth had a mild sore throat. Only two patients had an actual chill and only three complained of a chilly sensation. One-fourth complained of substernal discomfort which was usually a burning sensation, although a few complained of substernal tightness. There was no actual chest pain characteristic of pleurisy; no dyspnea or the expectoration of bloody sputum.

The physical examination at the onset was characterized by its lack of abnormal findings. In approximately three-fourths of the cases the chest was normal. In eight cases there were crepitant râles at the bases of the lungs, but most of these reported to the sick bay after having been sick for a few days. In a few cases sibilant râles were present and in about the same number sibilant and crepitant râles were both heard. These were usually located at the base of the lungs, posteriorly. Diminished breath sounds were present in a few cases and dullness on percussion in only one. There were no definite physical signs of pulmonary consolidation in any case at the onset of the infection.

The temperature curve varied moderately during the course of the disease. In the majority of the cases the temperature would rise to 101°-102° at the onset, remain elevated for 4 to 8 days, dropping gradually to normal. In about one-sixth of the cases the temperature was elevated to 103°-104° for several days. These patients were definitely sicker than the others, as manifested by

associated clinical evidence. In five cases there was a low-grade fever under 100° which ran from 12 to 23 days. The pulse temperature ratio was either normal or a relative bradycardia was present.

During the course of the illness the two most significant factors were the paucity of chest findings on physical examination and the persistence of râles once they appeared. In five cases râles were heard before the third day, but in these we were doubtful as to whether the history of the day of onset was accurate. In the large majority of cases râles were heard first from the fourth to the eighth day of the illness. In one-fourth of the cases no abnormal chest signs were ever apparent and in four cases râles were not heard until the ninth to the eleventh day. The râles were usually medium, moist in type, and usually persisted from 1 to 2 weeks.

In the large majority of cases the sputum was usually absent or very scanty for the first 4 or 5 days, and after that the patient expectorated small amounts of mucopurulent material for a few days.

Approximately one-half the patients were in the hospital for 3 weeks and the majority of the remaining were in about 2 weeks. A few cases were sent to duty in 8 to 10 days; these were very mild cases. In the majority of cases hospitalization was prolonged by the weakness of the patient, a persistent cough or râles after all other symptoms and signs had subsided. The complete recovery of the patient was essential in our cases because of the necessity that he be fit for any and all military duty before being allowed to leave the hospital.

There were no serious complications in any of our cases and no fatalities.

ROENTGENOLOGICAL DATA

The outstanding observation concerning the roentgenographic findings was the fact that changes within the lung were present for several days before they could be determined by physical examination of the chest. Three of our cases had roentgenograms as early as the second day, and changes were found in all of these. In Murray's series of cases changes were found within 24 hours after the initial symptoms.

The roentgenograms usually showed a small irregular or rounded area of soft to moderate homogeneous density in the central portion with borders shading into normal lung. In many of the cases the density was very thin, although of an even quality. This was particularly true of those lesions appearing in the costophrenic angle. As a whole, the lesions were not extensive, particularly those extending from the lower border of the hilus and those found in the costophrenic angle. It was our opinion that some of the lesions extending below and outside the left border of the heart would have been shown to be more extensive could we have obtained lateral roentgenograms of the chest. The distribution of the lesion was lobular rather than lobar and the majority showed only a small section of one lobe to be involved. In a few cases the lesion was more extensive, but these were the exception rather than the rule. Multiple, successive roentgenograms in several cases demonstrated that as the disease progressed the density increased, became more sharply defined and frequently increased in size. Also, resolution was shown to follow the course of other types of pneumonia, the density gradually diminishing and becoming more mottled and linear in type.

In the majority of cases, approximately three-fourths, the lesion either extended from the lower border of the hilus region into the cardiophrenic angle, or appeared either in the costophrenic angle or at the base of the lower lobe of the lung. Sixteen cases had lesions at the left base, 7 at the right base, and 5 at both bases. Seven cases extended from the hilus toward the midportion of the lung. In 4 cases the lesion occurred in the upper lobe, and in 2 cases there were lesions in both upper lobes. In 1 case, lesions were located in the right upper and lower left lobes.

LABORATORY DATA

The average case showed a normal or slightly elevated initial leucocyte count and a normal to slightly elevated percentage of polymorphonuclear cells. Only 2 leucocyte counts were below 6,000 and the majority ranged between 6,000 and 9,000; 6 counts were above 10,000, but a few of these were obtained late in the disease.

Because of several factors inevitably concomitant with the commissioning of a new hospital, we were unable to carry out extensive bacteriological studies. We were unable to inoculate any animals with either the blood, sputum, or nasopharyngeal washings of any of our patients. In one-sixth of the cases we examined the sputum for tubercle bacilli and the predominating type of organism. Tubercle bacilli were not found in any specimen examined. Staphylococci, streptococci, pneumococci and Micrococcus catarrhalis were the predominant organisms found. When pneumococci were found present, we attempted to determine the type but were unable to do so except for one case which was pneumococcus type IX. The sedimentation rate was moderately elevated in the large majority of cases.

TREATMENT

The treatment was largely symptomatic with the emphasis on rest, supportive measures, and sedatives for cough and restlessness. In 12 cases sulfathiazole was administered with 30 to 90 grains given initially and 15 grains thereafter every 4 hours night and day.

We were definitely convinced that the drug was not as effective in this group as in the usual pneumococcic infections, and there was considerable question as to whether it had any beneficial effects.

SUMMARY

A series of 40 cases of an acute infectious disease of the respiratory tract with unusual pathologic changes in the lung have been described and analyzed. In general, our cases closely resemble those described as some type of pneumonitis by workers in the United States and abroad.

The majority of the cases in this series began as a simple acute infection with minimal respiratory and constitutional symptoms; a normal or slightly elevated leucocyte count and no abnormal physical signs. The diagnosis was usually made by means of the roentgenogram and *in the large majority of cases could not be made by any other means.* It usually showed a small area of increased density most often located at the base or hilus of one lung. Abnor-

mal physical signs in the lungs, usually manifested by crepitant râles, were not apparent until the peak of the severity of the disease had passed. Although the constitutional symptoms were not severe, a prolonged period of convalescence was usually required because of the weakness of the patient.

The pathology and etiology of this disease are still undetermined, although there is some evidence to indicate that it is caused by a filtrable virus.

The disease is apparently contagious, but only mildly so, and is probably transmitted by casual contact.

Lack of physical fitness, previous upper respiratory infections, abnormal exposure, or physical fatigue were not predisposing factors.

The disease did not respond favorably to the action of sulfonamide chemotherapy.

The study of our series and the reports of other workers who have observed similar outbreaks impresses us with the fact that many factors remain to be studied before the entire field of acute respiratory infections can be charted and particularly is this true of those caused by a filtrable virus.

We agree with Francis that this can be achieved only by clinical epidemiological methods and that by comparing the clinical differences in patients and epidemics with specific laboratory data, the various entities will fall into their proper places in the puzzle of epidemic respiratory disease.

BIBLIOGRAPHY

1. Allen, W. H.: Acute Pneumonitis, Ann. Int. Med. **10**: 441-446, October, 1936.
2. Ackerman, A. J.: Roentgenological Considerations of Influenzal Pneumonitis, Am. J. Roentgenol. **46**: 175-181, August, 1941.
3. Bowen, Albert: Acute Influenza Pneumonitis, Am. J. Roentgenol. **34**: 168-174, August, 1935.
4. Bullowa, J. G. M., and Wilcox, Clare: Endemic Pneumonia, Ann. Int. Med. **59**: 394-407, March, 1937.
5. Cass, J. W., Jr.: Question of Influenza and Atypical Pneumonia, New England J. Med. **214**: 187-193, January, 1936.
6. Gallagher, J. R.: Broncho-pneumonia in Adolescence, Yale J. Biol. & Med. **7**: 23-40, October, 1934.
7. Gill, A. M.: Pneumonitis, Brit. M. J. **1**: 504-507, March, 1938.
8. Francis, T. F., Jr.: Epidemic Influenza; Studies in Clinical Epidemiology, Ann. Int. Med. **13**: 915-922, December, 1939.
9. Miller, F. N., and Hayes, M. G.: Broncho-pneumonia of Mild Severity at University of Oregon, N. W. Medicine **38**: 12-14, January, 1939.
10. Marfield, J. R.: Atypical Pneumonia With Leukopenia, Texas State J. Med. **35**: 340, September, 1939.
11. Murray, M. E., Jr.: Atypical Broncho-pneumonia of Unknown Etiology, New England J. Med. **222**: 565-575, April, 1940.
12. Reimann, H. A.: An Acute Infection of the Respiratory Tract With Atypical Pneumonia, J. A. M. A. **111**: 2377, December, 1938.
13. Reimann, H. A., and Havens, W. P.: An Epidemic Disease of the Respiratory Tract, Arch. Int. Med. **65**: 138, January, 1940.
14. Scadding, J. G.: Disseminated Focal Pneumonia, Brit. M. J. **2**: 956-959, November, 1937.
15. Lusiley, D. F., Showacre, E. C., Lee, W. F., and Ferris, H. W.: Acute Interstitial Pneumonitis, J. A. M. A. **112**: 1901, May, 1939.
16. Editorial: Virus Studies in a New Respiratory Infection, J. A. M. A. **115**: 2180-2182, December 21, 1940.

Erratum

On page 269 of the December issue of the JOURNAL, in an article entitled "The Effect of Testosterone Propionate in the Treatment of Arteriosclerosis Obliterans" by Herman Zurrow, M.D., Gamliel Saland, M.D., Charles Klein, M.D., and Stanley Goldman, M.D., New York, N. Y., the footnote "†Deceased" pertains to Dr. Goldman and not to Dr. Saland.

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